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# POWER

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# The Urge for Improvement

COMPARE the power plant of today with that of years ago.

Not so much, I mean, in its totally changed aspect as in the quality and fitness of its appurtenances and materials.

There seems to have been a constant urge for improvement.

What does it come from?

A maker of some appliance or supply seeks better material, better design, better workmanship and manufacturing methods.

Why?

To make his product last longer and reduce his income from renewals?

To establish superiority, win reputation and prestige and back his competitors off the map?

Are the problems, difficulties and criticisms of his users a challenge that puts him on his mettle?

Is it a sense of craftsmanship, of pride in his product, of ambition to excel, a striving for mastership in his line?

Or is it an innate sense of service, a subconscious realization that his part in the established order is to do the job that he has cut out for himself the best that it can be done?

Whether it be any or all of these, the operator of a power plant is the beneficiary.

That they may serve him better, may help him to solve his problems, may make his work easier and more effective and the operation of his plant safer and more economical, trained scouts explore the realms of physics, chemistry and metallurgy, inventors and designers exercise their ingenuity, production engineers and managers evolve methods, and manufacturers and merchants invest their capital, seeking his commendation and patronage.

And when this thought is applied to all of the numerous components of his plant and the essentials of its maintenance and operation, one begins to realize what an aggregation of intelligence, enterprise, talent and means the power-plant engineer has at his command.

F. R. Low

## POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

### Centering Responsibility

THE article in last week's issue, by J. N. Landis, describing the main features of the 110,000-kilowatt unit recently placed in operation at the Hudson Avenue station of the Brooklyn Edison Company, disclosed some interesting purchasing policies. One was the placing with a single manufacturer of the responsibility for furnishing all equipment closely related to that company's specialty. Thus one concern was awarded the contract to furnish the turbine, condenser, air ejectors and circulating pumps. Similarly, the contract for the boilers, boiler settings, soot blowers and boiler accessories was let to another.

Such centering of responsibility has much to commend it. The many small discussions that take place when two or more contractors work on the same unit are by this means eliminated and plant construction is greatly facilitated.

Also, when a machine fails to meet guarantees, the manufacturer has frequently placed the blame upon a closely related piece of equipment. With this purchasing policy the possibility of such alibis is reduced.

### Why Place Emphasis on Starting Torque?

SYNCHRONOUS motors have been developed to where they are one of the most important industrial power drives. A recent tabulation showed one hundred and seventy places in fifty different industries where these motors are used. With the earlier types of motors the problem of sufficient starting torque was a serious one. This difficulty has been overcome in present designs, but the old idea seems to prevail in the minds of many engineers. When they consider synchronous motor applications, the question of starting torque is made a major issue.

It is not so much a question of how much starting torque the motor can develop as of how much the particular application requires. If the starting torque is the only consideration, it can be given almost any reasonable value. There are, however, many other considerations in the application of synchronous motors, just as there are with other types.

There are three different torques to be considered—starting, pull-in and pull-out. All three cannot be made high in a given synchronous motor, and there are very few applications where it would be advantageous to have all of them high. What is required is an adjustment of the torques to suit the loads. This the designer can do if he knows the application characteristics.

For starting a centrifugal pump the required starting torque is low, whereas the pull-in torque is high. The load builds up rapidly and reaches a maximum value at full speed. In such applications pull-in torque is one of the major considerations. With a conveyor that may be subjected to low temperatures, a high starting torque is required. In such applications starting torque is a dominating factor. For crushers and for metal-rolling applications high pull-out torque is desirable.

Making starting torques or any other characteristic the ranking consideration, without knowing what is required, is not the way to obtain a motor best suited to the drive. All factors should be given their proper weight in the selection of synchronous motors, just as they should be when choosing other types.

### Better Use of Byproduct Power

IT HAS been said that a condenser is an anachronism in any industrial plant using large amounts of process heat. This statement can hardly get by as a generalization, but it does lean in the direction of sound thinking.

Certainly, discharged condenser circulating water represents an energy waste exceeded only by that of free atmospheric exhaust. The ideal industrial power layout is one in which neither steam nor warm circulating water passes out of the plant. The next best is the layout in which no exhaust is wasted and the energy discharged in circulating water is kept down to the absolute minimum.

The first ideal is obtainable only where the process steam required, per horsepower used, always exceeds the steam rate of first-class non-condensing units operating under the given back pressure. For example, a plant constantly demanding forty pounds of low-pressure process steam for each horsepower of power load, could hardly find a good excuse for using a condensing or even a bleeding unit. This setup clearly calls for engines or turbines exhausting directly to the process. If these units are a little more efficient than necessary, and therefore do not supply quite enough process steam, the remainder can be furnished directly from the boiler through reducing valves without loss of usable energy. In such cases the use of low-efficiency steam-driven pumps and engines for power-house auxiliaries, and for power services in the manufacturing plant, does not increase the fuel bill as long as the total exhaust steam from all sources does not exceed the process demand.

Few industries, however, can boast such an ideal condition. Generally, more power is needed, for certain periods at least, than can be generated from back-pressure units and auxiliaries supplying process steam. If the margin is slight, it may be taken care of by replacing small steam pumps, engines and other inefficient steam-driven auxiliaries by motor-driven units. Where this is not enough, further gain can be made by decreasing the steam rate of the main units through better design, higher boiler pressures and lower process pressures.

If there is still an excess of exhaust steam, fuel economy requires the installation of condensing or bleeder units to squeeze the last bit of power from that portion of the boiler steam which cannot find its way eventually to process.

These are the main points, but in practice there are many complications and possible refinements, such as partial recovery of the heat in circulating water. This variety of possible solutions makes it necessary for the power engineer to study many combinations in order to develop a flair for finding the best solution to his own power-heat problems. That is why an article on the heat-power balance of the paper industry, such as that by W. T. Miller in this issue, is just as valuable to a power engineer in a textile or chemical plant or a tannery, as to the man in a paper mill.

## The Power Function in Industry

WIDELY as industries may differ in production methods, materials, labor requirements and other factors, there are certain functions common to all. Concerning these which include administration, management and power, one industry may learn from another. Advances in the generation and application of power made by one industry, for instance, are of immediate help to many others.

And just as this power function is found to exist throughout all industry, so is there a type of specially trained man needed by all industry for power supervision. This man, the industrial power engineer, does not have exactly the same set-up to deal with in each industrial plant. But the same fundamental knowledge and experience are essential to him in the carrying out of his duties.

But what chiefly distinguishes the power engineer in industry from other power engineers, such as those in public utility power stations, is the outlook that he must have toward the results of his work. The central-station power engineer is working toward the delivery of power most economically to the station switchboard. Therefore his first interest is in the efficiency of the equipment and his second is in the economy of operating and maintenance methods. His interest in other factors need be but slight.

In industry, however, the power engineer must devote most of his thoughts to other things. Industrial plants exist for the purpose of turning out some product. Every factor entering into the cost of this product must be kept at a minimum. The power engineer must continually think: "It is not how efficiently I make power that counts; that is only one part of my job, which, viewed as a whole, is to make sure that the power cost entering into the total production cost of each piece of goods this factory makes is as low as I can get it." The power function in industry is the supply, with the utmost economy, of the energy needed for production work.

## A Matter of Definition

BRITISH engineers refer to the equipment used for the generation, transmission and application of power as "power plant." This term has a different significance in America, where a power plant is considered to embody only the buildings and equipment necessary for power generation. There is no collective term in use in this country by which a power engineer can speak of all that is under his supervision.

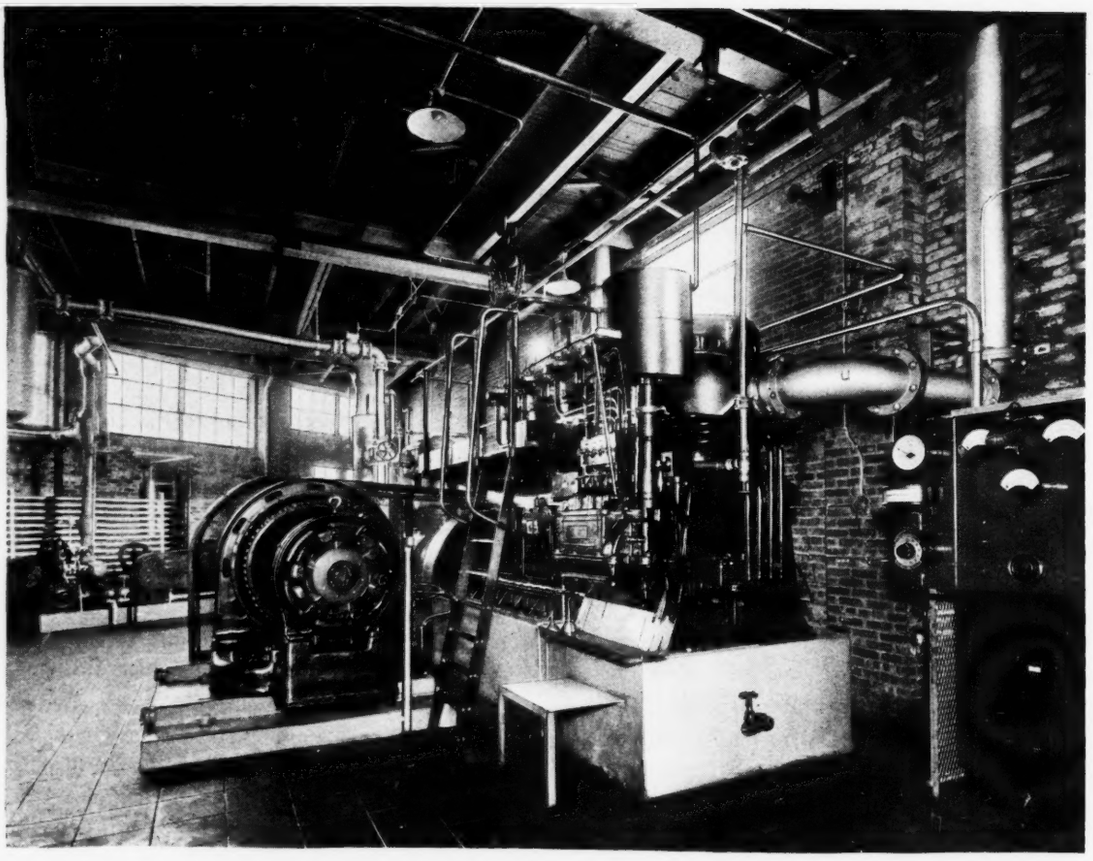
This American usage is somewhat unfortunate, for it promotes a tendency to look upon the power engineer as a man concerned solely with power generation. With the English definition in mind, there is a clear idea of the responsibility and scope of the engineer's work. But where "power plant" is taken to mean only "generating station," the existence of many of the engineer's multifarious duties is likely to be ignored by, or unknown to, some managers and industrialists.

Knowledge of what a power engineer does in an industrial plant should be widely spread, so that industry has no misconceptions. It is in plants where this knowledge does not exist, that important power applications are put in the hands of unqualified men, and steam and other power services are wastefully used. It is up to the engineer to see that industry makes full use of his capacities, for his own good and so that these wastes do not occur.

## The Last Word Is Never Said

TO SAY that anything is so, involves a certain risk. Change, rather than stability, is the ordinary lot in human affairs, to which engineering is no exception. And for this reason if for no other, the recent statements of prominent engineers that the water wall is the solution of furnace difficulties and will fully replace refractory walls, must be accepted only with reservations.

The object of a furnace is to provide a space for the combustion of fuel to be carried out in such a way that the resulting heat is, as fully as may be, absorbed by the fluid in the boiler, this heat absorption being at the desired rate or rates. Under present conditions of boiler firing, particularly with powdered coal as fuel, it happens that the water wall is proving highly suitable. But it is well for the engineer to remember that conditions do change, to keep his mind open and to be prepared to abandon the water wall if, and when, future developments make such a course desirable.



# A Modern Ice Plant Uses Oil Engines

By F. S. Strite

*Mechanical Engineer,*
*Knickerbocker Ice Company*

THE Knickerbocker Ice Company, of New York, a subsidiary of the American Ice Company, recently put into operation a new 45-ton ice plant at Great Neck, New York. This is the thirty-fifth plant built by the company, of which number four use oil engines.

This plant is typical of all other plants recently designed and built by the American Ice Company, and each unit is designed with the following definite points in view:

The quality of the product must be uniformly of the best in purity and appearance.

The loading platform and yard must be of ample size and easy of approach from the main thoroughfare, and proper facilities must be provided for delivering ice on the platform in front of the loaders so that no time will be lost in loading.

The building must be of simple but substantial construction and in a single story if cost of ground permits. It must be a dignified structure of pleasing proportions, without attempts at elaboration, but in harmony with the surroundings.

All the machinery and the freezing tanks must be in one room and the entire plant, including the loading yard and day storage, arranged on one floor.

The machinery must be of simple and sturdy design, to obtain utmost efficiency and to insure long life and minimum of upkeep.

Provision must be made to arrest corrosion from the very start in all parts of the plant, and to cut down depreciation and maintenance, which is a vital factor, for the American Ice Company has 74 plants to operate and maintain.

The concrete building foundations carry the steel columns and pilasters, which are filled in between with brick masonry. Galvanized steel sash is used throughout, having glazed crystal clear glass in the engine, tank-rooms and garage.

The day-storage walls are of double-brick construction, with regranulated cork filled in between. Sheet cork is placed in the top of the ceiling and covered with slag roofing membrane. Cinder-fill insulation and oak planks form the floor. The room is refrigerated with 2-in. D.E. piping. A four-tier ice portable benching machine is used. The same construction is employed for the ice storage house, which has a capacity of 2,500 tons. The floor, however, is made up of $1\frac{1}{4}$-in. square-edge boards and 3x4-in. grilling. This house also is refrigerated with 2-in. D.E. pipe and is equipped with a gig elevator for handling the ice.

### Engine Room Construction

Wooden posts are provided in both the day storage and the icehouse for carrying the roofs as well as the 2-in. piping, which is placed on the ceiling in both cases. Brick pilasters and steel columns and beams are used for carrying the roof of the engine and tank rooms. These roofs are composed of sheathing and covered with slag roofing membrane.

The loading platform is of substantial construction with an approach consisting of an 8-in. reinforced paving. A fireproof steel canopy completes this part of the plant.

The sales office of brick construction is adjacent to the loading platform. A modern 25-truck garage of brick and steel construction adjoins the engine room. A 4,000-sq.ft. fire-tube heating boiler is installed in a corner of this garage for heating the ice plant and garage by means of unit heaters.

Refrigeration is obtained from a 12.5x12-in. Frick vertical single-acting two-cylinder ammonia compressor operating at 258 r.p.m. The cylinders are equipped with multiple poppet suction and ring-plate discharge valves, automatic force-feed lubrication, and water-jacketed heads.

This compressor is directly connected through a flexible coupling to a 225-hp. Bethlehem four-cylinder, two stroke-cycle Diesel engine. This unit has force-feed lubrication for all bearings and pins, and an automatic device for stopping the engine in case of excessive ammonia discharge pressure. The flywheel is crowned for belt driving a 75-kw. direct-current generator for supplying current for driving all the auxiliary motors in the plant.

### Engine Is Noiseless

The engine is equipped with oversize Maxim Silencers for both exhaust and air-intake muffling. These mufflers eliminate all exhaust noise, a necessary precaution in a residential district. It is impossible to hear the ma-

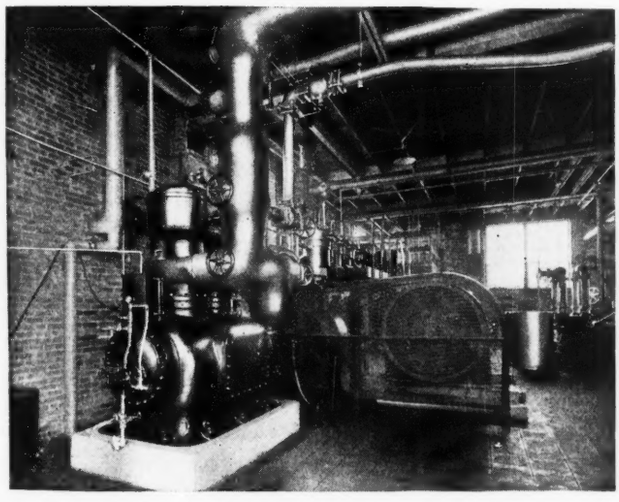


*Fig. 1—View of the compressor*

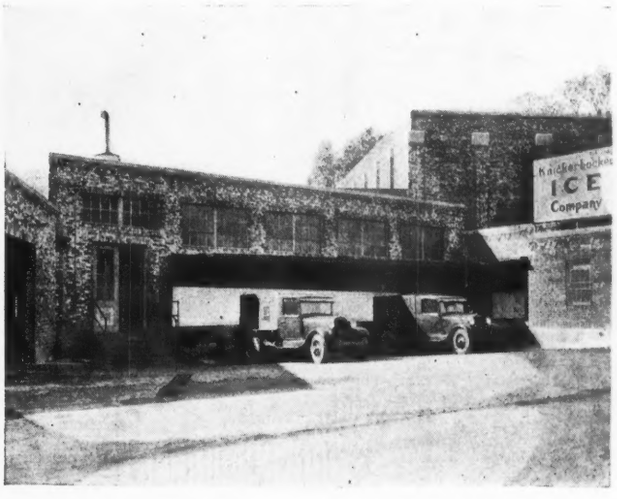



*Fig. 3—Exterior of the plant*

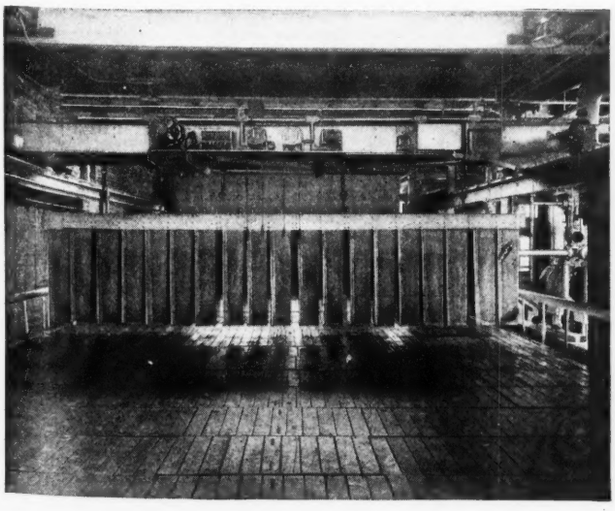


*Fig. 2—Ice is pulled in gangs*

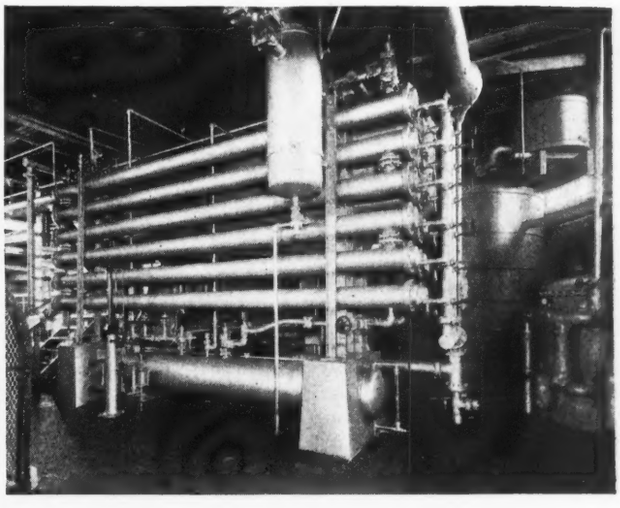


*Fig. 4—The multi-pass condensers*

chinery although before the addition of the silencers there were some objections.

Fuel is delivered by tank engines to a 10,000-gal. steel tank. The plant could have been built where barge delivery would be possible, but this would entail the hauling of the ice up rather steep inclines, thereby slowing up deliveries and increasing the cost of distribution.

There is an auxiliary air compressor set consisting of a two-horsepower Mianus gasoline engine driving a Mianus compressor.

A 5x5-in. vertical single-acting York ammonia compressor, belt-driven by a ten-horsepower gasoline engine, was installed, to be used as a spare for refrigerating the large ice storehouse.

The ammonia condensers are of the multi-pass multi-tube type, set in two stands, six pipes high; the shells

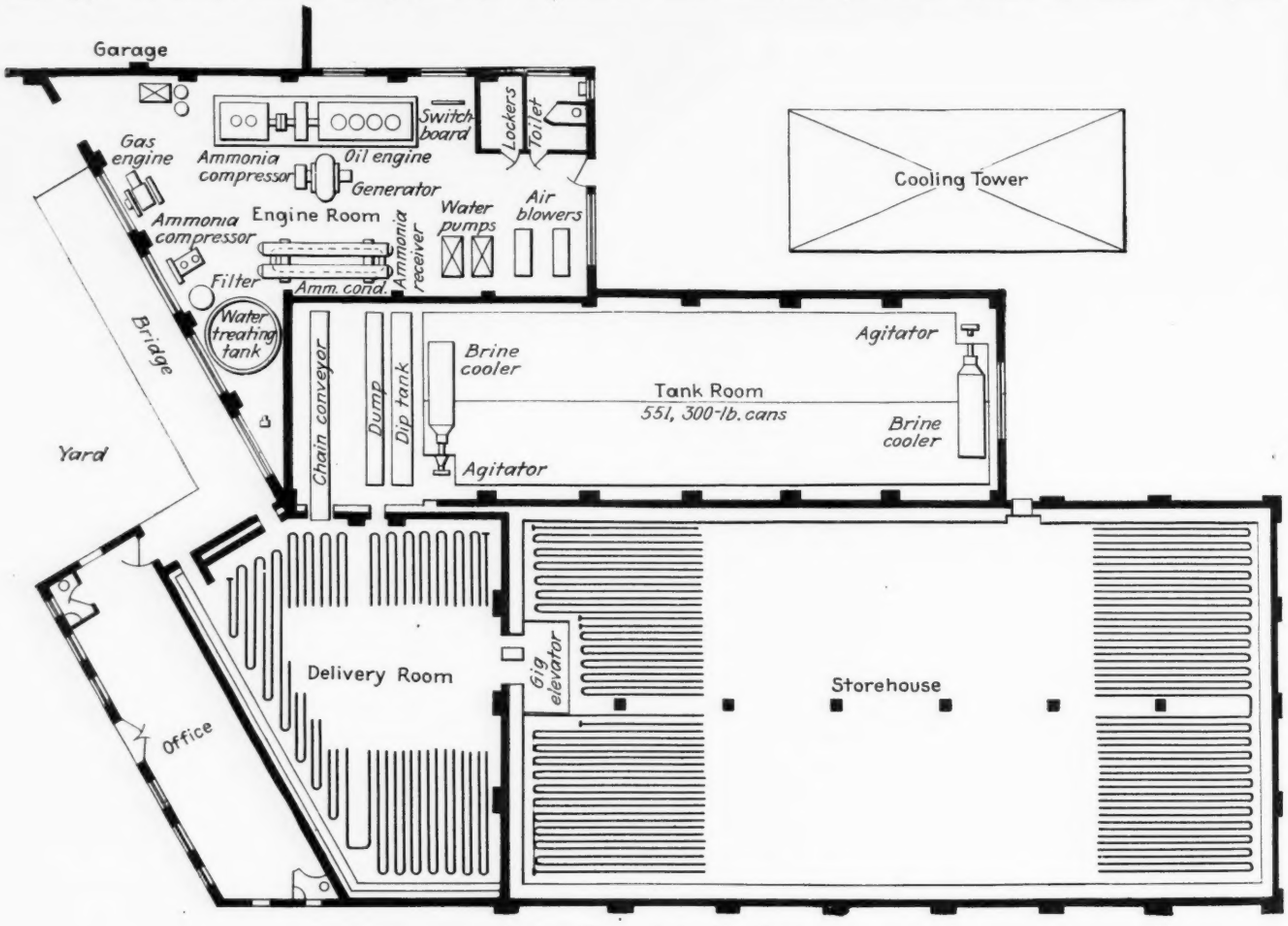



*Fig. 5—Plan of the ice plant*

are 8 in. in diameter and 18 ft. long, each containing seven 2-in. No. 9 gage galvanized seamless steel tubes, which are rolled into heads and then welded.

There is one freezing tank 67 ft. 9½ in. long, 20 ft. 8¼ in. wide and 54 in. deep, made of ¼-in. steel; it holds a total of 551 three hundred-pound ice cans. This tank has two shell-and-tube brine coolers 42 in. in diameter by 10 ft. long, each containing 212 No. 9 gage 2-in. seamless steel tubes giving a total of 2,228 sq.ft. of tube surface. Each cooler is equipped with a 16-in. propeller and hood, with a cone-shaped steel plate enclosure for the end of each cooler. Swift brine flow is maintained with a minimum of power and a small difference in levels, and for quick freezing, the top of the ice in the cans is kept well below the brine level. The tank is arranged for full-row harvesting and is equipped with a five-ton two-motor crane, as well as a row dip, dump and overhead can-filling tank. This reduces the tank labor to a minimum.

An ammonia oil distiller is connected so that oil can be extracted from all coolers and points in the high- and low-pressure sides. A foul-gas purger is also connected for eliminating foreign gases.

All electric wiring that is run under the concrete floors and in ice storehouses is lead covered, and is installed in accordance with the New York code.

The ice cans, can grids and aërating system were furnished by the Knickerbocker Stamping Company. The ice cans are 11x22x51-in. inside and are made of No. 14 galvanized steel. The can grids are of special design, riveted throughout and galvanized after fabrication to insure complete protection against corrosion. The grids weigh 51 lb. per can and are of sufficient weight to submerge the cans properly in the brine, and rest on wood strips on the bottom of the freezing tank at four points in each row. This insures a level tank top with lids resting directly in the grids, there being no wood framework on top of the tank.

The aërating system is of the low-pressure mechanical pendulum type, using less than two pounds air pressure. The air is introduced into the cans through the swinging drop pipes connected to laterals. Each lateral serves one-half row and rests in the notches provided in the grid cross-members, and they are coupled through an automatic air-valve connection to the main air header and the sliding rack which imparts the rocking motion to the lateral. The racks travel on special roller bearings the full length of and parallel to the freezing tank

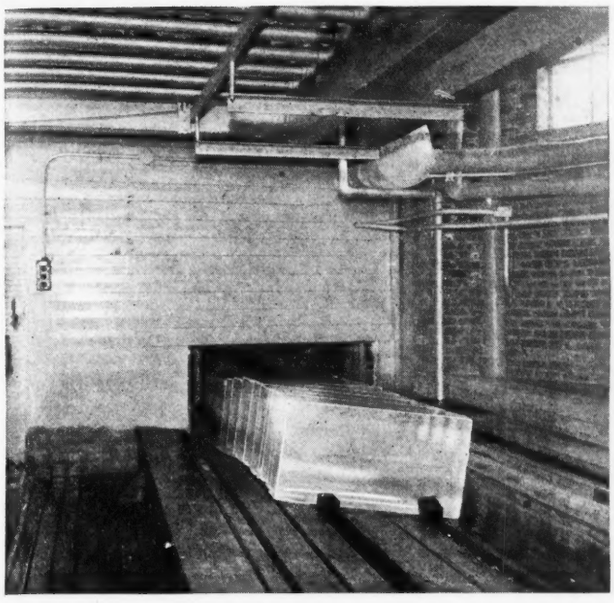


*Fig. 6—The ice chute*

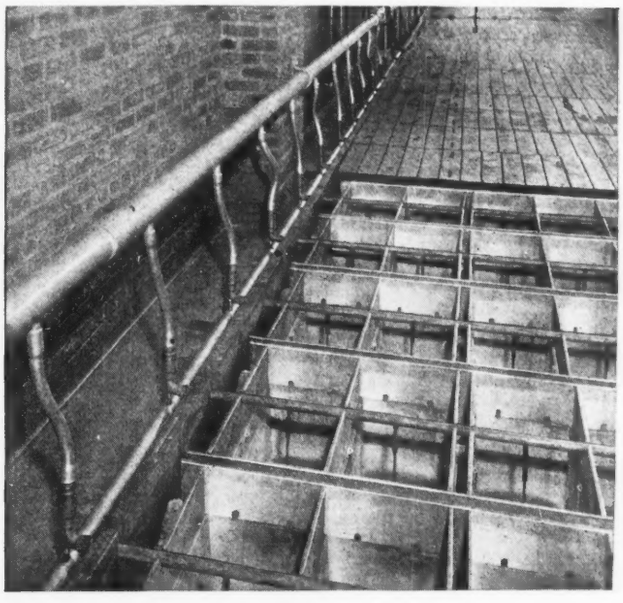


*Fig. 7—The Knickerbocker air-agitation system*

and make seven strokes per minute. The racks are moved through eccentrics placed on a shaft at the end of the tank, the shaft being turned through a reducing gear by a one-horsepower motor. The air is furnished for this system by two centrifugal blowers direct connected to motors.

The safety valves on compressor, coolers, condensers, liquid receiver, as well as the automatic high-pressure cutout and diffusers, were installed in accordance with the National Safety Code for Mechanical Refrigeration, recently revised by the American Society of Refrigerating Engineers.

Thermometers were installed in each suction and discharge line at compressor, freezing tank, incoming and outgoing water lines at condensers. Indicating pyrometers register the engine exhaust temperatures and venturi meters indicate the flow of ammonia liquid going to the freezing tank. The plan is to make the operation of the plant easy and to reveal any defect before breakdown occurs.

The ice is made from city water, after treating, precooling and filtering in a treating plant consisting of an open-top wooden tank of sufficient capacity for four hours of settling time; it has a chemical-feed control system on top, and a 36-in. closed type sand-and-gravel filter. There are 500 lin.ft. of 2-in. galvanized direct-expansion piping in the wooden treating tank for precooling.

The ice-handling conveyor, a double-chain type, is arranged to convey a full row of nineteen cakes from the dumping platform into the day storage. An ice-scoring machine is installed. It receives ice on edge and delivers scored cakes on end from the machine ready for the delivery wagon.

Water for the condenser and engine cylinder jacket is cooled in a tower 38 ft. long, 14 ft. wide and 30 ft. high. There are two centrifugal water circulating pumps of 300 and 500 g.p.m. capacity; these are of the double-suction type. The circulating system is of the closed type, using galvanized piping throughout to reduce the corrosion danger.

The general building contractor was L. M. Neckerman Company, Inc., of New York City, who also furnished and installed the cork insulation. Complete architectural building plans were made by the American Ice Company's Building Department.

## PRINCIPAL EQUIPMENT KNICKERBOCKER ICE PLANT

| | | | |
|---|---|---|---|
| Ammonia compressor | The Frick Co. | Air agitators | The Knickerbocker Stamping Co. |
| Oil engine | Bethlehem Steel Co. | Air blowers | Allin-Billmyer Co. |
| Stand-by compressor | York Manufacturing Co. | Water filter | International Filter Company |
| Ten horsepower gasoline engine | Fairbanks-Morse Co. | Ice conveyor | Gifford-Woods Company |
| Auxiliary air compressor | The Mianus Co. | Ice-scoring machine | Perfection Scoring Machine Co. |
| Compressor packing | Garlock Packing Co. | Cooling | Water Cooling Equipment Co. |
| Silencers | Maxim Silencer Co. | Centrifugal pumps | Bethlehem Steel Company |
| Fuel-oil tank | Letonia Boiler Works | Storage-room piping | The Frick Co. |
| Switchboard | Empire Switchboard Co. | Ice benching machine | Gifford-Wood Co. |
| Ammonia condensers | The Frick Co. | Gig elevator | Gifford-Wood Co. |
| Ice tank | The Frick Co. | Heating boiler | James Russell Boiler Works |
| Agitation propellers | The Halversen Co. | Unit heater | Modine Manufacturing Co. |
| Can motor crane | Euclid Crane & Hoist Co. | Thermometers | Simplex Valve & Meter Co. |
| Wiring and conduits | The Arc Electrical Construction Co. | Pyrometers | Simplex Valve & Meter Co. |
| Ice cans | The Knickerbocker Stamping Co. | Venturi meter | Simplex Valve & Meter Co. |

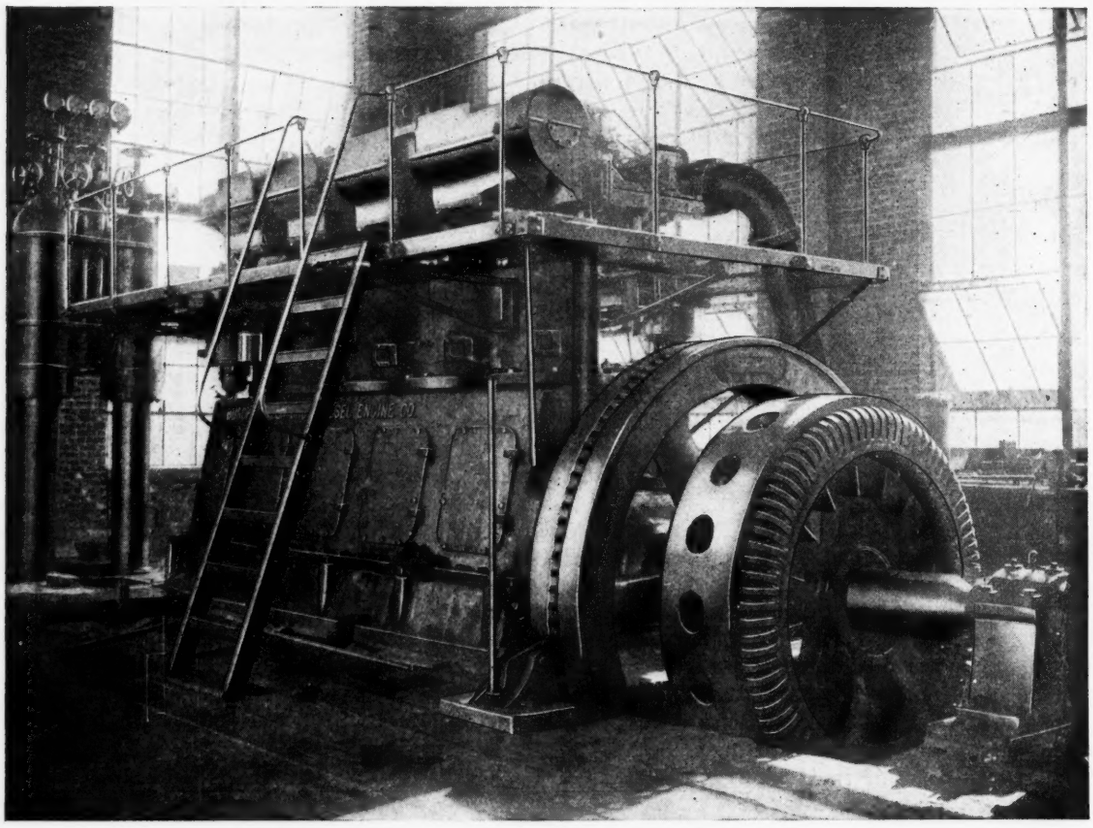


*Fig. 1—The Greenport Diesel plant*

# DIESEL SAVES MONEY

## *In Greenport Steam Plant*

THE Greenport light plant, as was the case with the other two Long Island, New York, municipal light plants, came into existence as a steam plant but changed to Diesel power.

The first generating unit, installed years ago, was a 16x36-in. Fishkill Corliss belt driving a 150-kva. two-phase generator. Steam was supplied by two 72-in. by 20-ft. Dillon horizontal fire-tube boilers. This equipment became overloaded, and in 1923 the city decided to increase the plant's capacity. Serious consideration was given to the oil engine at that time, but the final decision was to install a 20x36-in. Corliss direct connected to a 350-kva. alternator and a third 72-in. by 20-ft. boiler, hand firing being still followed.

The steam plant at that time contained an open heater and a duplex boiler-feed pump. To supply water for the city water works, there were two Worthington steam-driven duplex pumps and a 250-g.p.m. Cameron centrifugal pump direct connected to a 10-hp. two-phase 1,750 r.p.m. motor in the power plant, and a 10x12-in. 750-g.p.m. Goulds triplex pump driven by a 40-hp. motor located at a well site some distance from the power house. These wells are shallow, obtaining what is essentially surface water at a depth of 35 ft. Deeper wells invariably have produced salt water.

In 1927 a second addition to the plant became imperative, and the records of other New York Municipal plants induced the town council to select a Diesel engine.

The Busch-Sulzer Bros. air-injection Diesel purchased is shown in Fig. 1. This has four cylinders $16\frac{1}{4}$-in. bore by 23-in. stroke and at 225 r.p.m. has a rated capacity of 400 hp. A 340-kva. Westinghouse two-phase alternator and its exciter are direct coupled to the engine.

The air bottles for the starting and injection air are placed on pipe pedestals to bring the control valves level with the engine platform. This is a desirable arrangement, as it permits one operator to inspect the valve gearing when he starts the engine.

Air for the working cylinders is obtained from outside the building through a steel pipe line protected at the intake by a Reed three-unit air filter. The compressor intake is inside the building and is protected by a small built-in filter.

To recover part of the heat in the exhaust gases, a Davis exhaust-gas boiler was installed. This boiler was built for 200 lb. pressure and is supplied with $1\frac{1}{4}$-in.

charcoal iron tubes. With an exhaust-gas temperature of 600 deg. F. and a water-inlet temperature of 60 deg. F., the outlet water averages 200 deg. F. On full load the engine exhaust reaches 900 deg. F. and the water flow through the heater is increased to absorb part of the additional heat. This water from the open feed-water heater passes through the Davis heater on its way to the boiler. The heater is not insulated, for the plant has no radiators and the heater helps keep the plant warm.

### The Fuel Supply

A Diesel fuel of 28 to 30 deg. Baumé gravity is used; this costs 7¼c. a gallon delivered by tank wagons to the plant. The oil marketing companies will not make enough reduction for a carload purchase to justify the running of a pipe line to the railroad.

This fuel is stored in an underground tank outside the building and is pumped by a motor-driven rotary pump to a service tank inside the building and above the engine.

Cooling water is stored in an outside concrete tank, Fig. 2. This pit is 48 ft. long, 16 ft. wide and 9 ft. deep. The depth is twice that necessary, but as there is gravel below the five feet of loam overburden, the pit was made deep enough to give sufficient gravel for the concrete. Makeup water is obtained from the city mains. Cooling water from the pit is pumped through the engine by a 150-g.p.m. Worthington centrifugal pump direct connected to a 1,750-r.p.m. Westinghouse motor placed in a pit under the engine-room floor. The water is discharged into a concrete sump just outside the engine room. From here it is taken by a second 150-g.p.m. pump and is delivered over the Buhorn cooling tower shown over the tank in Fig. 2. This pump is provided with a quick-opening throttle valve in its discharge, attached to a float in the sump. When the water level drops, the pump's delivery is reduced through this throttling, without a change in motor speed.

The cost of the building addition, the oil tank, cooling pond, engine and all the other equipment is shown tabulated in Table I. It should be stated that the plant addition was made large enough to accommodate two more units, as was the cooling pond and oil tank. This oversize somewhat influences the cost per kilowatt capacity; the same applies to the rebuilding of the switchboard, for a board for the new unit would not cost over $1,500.

TABLE I—COST OF PLANT EXTENSION

| | |
|---|---|
| Building | $9,955.00 |
| Labor on foundations | 856.00 |
| Painting new and old building | 559.00 |
| Engine, 400-hp., including equipment and erection | 27,082.00 |
| Generator and exciter, 340 kva | 3,380.00 |
| Engine foundations, labor and material | 1,734.00 |
| Erecting engine, labor | 1,588.73 |
| Hauling machinery | 1,055.84 |
| New floor in old and new plant | 442.02 |
| Cooling pond, labor and material | 2,068.65 |
| Cooling tower | 833.00 |
| Crane, 10-ton | 1,882.91 |
| Switchboard, labor and material | 5,601.16 |
| Exhaust boiler and piping | 1,554.39 |
| Total | $58,592.70 |
| Cost per engine horsepower | $146.48 |

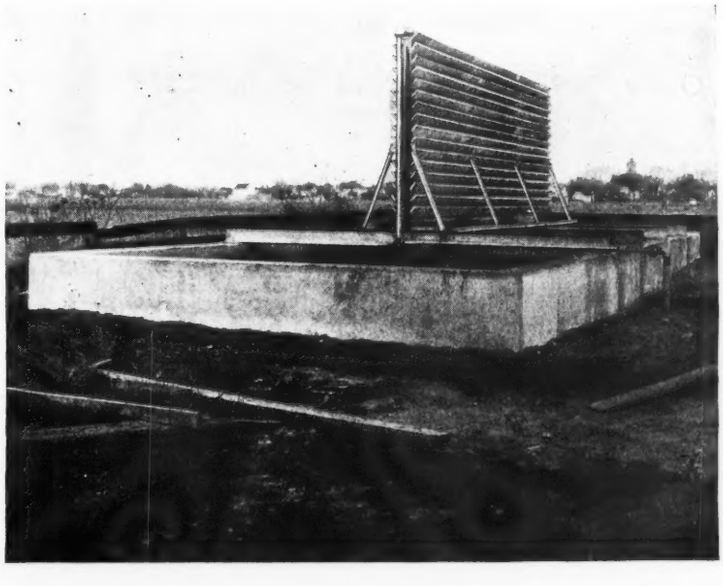


*Fig. 2—The cooling tower and the concrete water pit*

This unit has been in operation for over a year and has never been down when needed. It runs continuously from Monday morning until Sunday night, at which time it is shut down and examined. At each shut-down one exhaust valve is reground if necessary, so that each valve receives attention once a month. The spray valves go about nine months before regrinding is needed.

TABLE II—FUEL AND LUBRICATING OIL CONSUMPTION

| Diesel engine: | | Steam plant: | |
|---|---|---|---|
| Kilowatt-hour output | 508,600 | Kilowatt-hour output | 96,400 |
| Fuel oil, gal | 50,400 | Coal, tons | 517.3 |
| Fuel oil cost at 7¼c. | $3,654 | Coal cost at $7 | $3,981.48 |
| Lubricating oil, gal. | 171 | Lubricating oil, gal. | 30.5 |
| Lubricating oil cost | $94 | Lubricating oil cost | $15.25 |

### Handling the Boilers

Fires are carried banked under the boilers, and the steam engines are started up each evening to help carry the peak load. This, of course, makes the coal per kilowatt-hour high, and to hold this to the minimum, the steam engines are shut down as early as possible. It is planned to install oil burners under one or two of the boilers and operate the burners just enough to keep the boilers warm. The exhaust-gas heater will be reconnected so that it and the boilers are tied together. It is the belief that the water will circulate between the heater and the boilers, so that the latter will keep hot. A substantial saving in operation is expected. In spite of the banking coal, the generating costs of the plant are not high, considering its capacity. From March 1 to Aug. 31, 1928, the fuel and lubricating oil consumed were as shown in Table II.

The labor cost of the plant, including the water-works and the superintendent's salary, is slightly under one cent per kilowatt-hour. The total generating costs are, then, approximately 2.3c. per kilowatt-hour. If the Diesel be charged with all the labor, it is generating power for 1.7 cents.

The combination of steam and Diesel engines is one that is being adopted in many plants. Most municipalities cannot afford to install enough oil engines to meet the peak demand, and the savings made by the initial engine provides a means by which other units can be installed at a later date. The combination is especially advantageous when there is a sharp peak of short duration; here the overhead on a new unit may be so great per unit output, that the steam unit, although uneconomical in fuel, works out as the more economical.

# *A Practical System of*

# Maintenance Cost Accounting

## *for Power Stations*

By L. J. Levert

*United Electric Light & Power Company, New York City*

The power-station maintenance accounting system used by the United Electric Light & Power Company builds up information required by the accounting department and the utility commission from records designed for the practical guidance of the operating department. This system may easily be adapted to the needs of industrial plants.

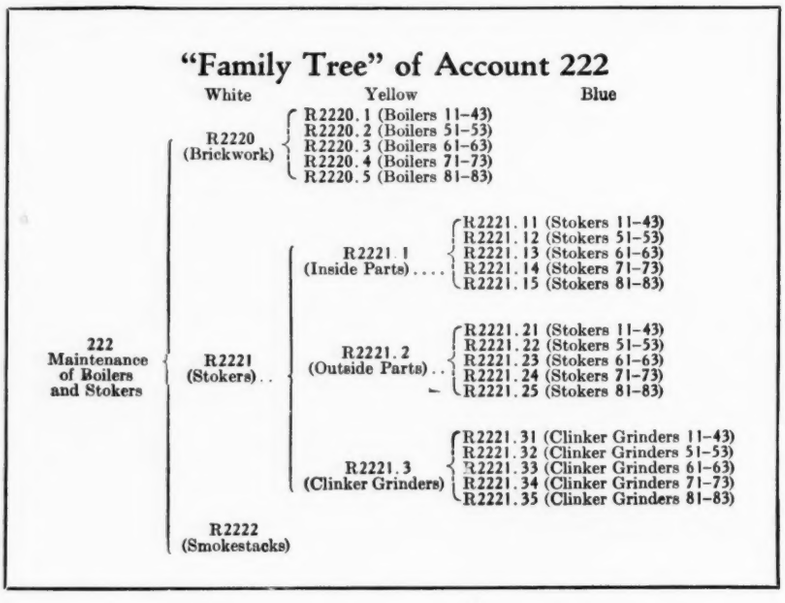
MUCH thought has been given to methods of keeping the fixed-capital records of public utilities, and a separate department which keeps a perpetual inventory record of the company's assets is more the rule than the exception. Practically all public service commissions require the use of the job-order system for fixed-capital accounts, as it helps to keep track of the construction work in progress and permits detailed analysis of the completed work. However, the ordinary method of keeping operating costs, although satisfactory from the accountant's point of view, does not go into sufficient detail for the engineering analysis.

Operating costs can be divided into four parts: Operation proper, fuel, miscellaneous supplies and maintenance. "Operation proper" includes the salaries of the supervising force as well as the wages of the operating crew. There is little variation in this cost from month to month, and it is affected but little by the load carried by the station or the method of operation. Its analysis is very simple, because a detailed split-up can always be gotten from the payroll department records. "Fuel" is by far the largest item of the operating cost; in modern power stations it runs as high as 75 per cent of the total operating cost. As a rule a detailed record is kept of the amount of coal received and burned in various boilers as well as the analysis of the fuel. Practically all modern power stations have an elaborate system for weighing and testing fuel. A detailed accounting system for the fuel will be of little assistance to the plant superintendent, as he is far more interested in the amount of fuel burned and its analysis.

The "miscellaneous-supplies" item is usually very small. This, of course, cannot be neglected altogether and an accurate record of the amount spent is essential. On account of the smallness of the amounts involved, however, it is hardly worth while to use a detailed sub-account system for it.

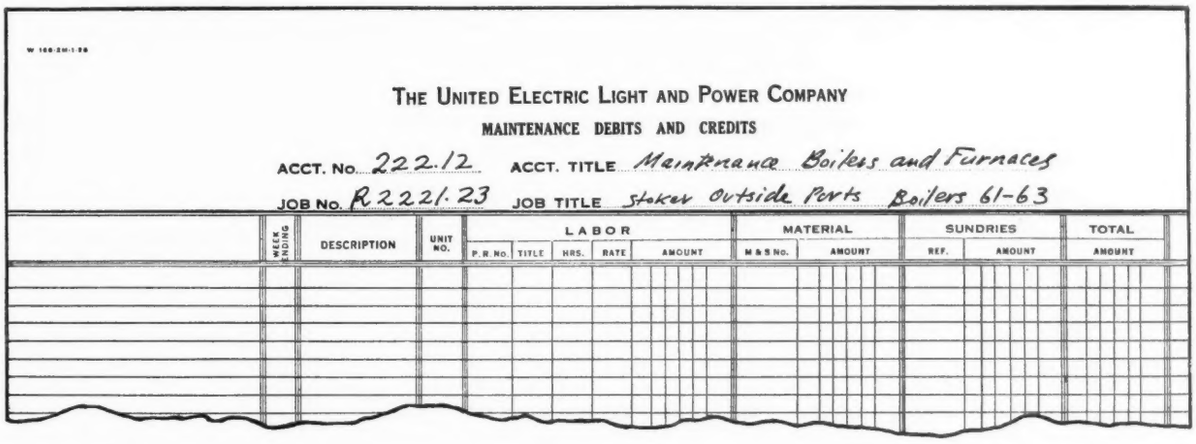
The situation is different, however, when dealing with the maintenance costs. These vary from month to month and are affected to a large extent by the load carried by the station as well as the method of operation. A correct distribution of maintenance cost is essential. It is difficult to get a correct picture of the relative merits of the various pieces of station equipment unless there are means of determining their respective maintenance charges.

The main difficulty in keeping the proper record of the maintenance cost is that individual maintenance accounts include too many items. For instance, an account used by a large public utility includes the following equipment: Feedwater pumps, induced-draft fans, coal-handling equipment, feed-water heaters, economizers, boilers, cinder catchers, pulverized-fuel equipment and blowdown tanks. It is apparent from this enumeration that the total of this account will give but little information to the



man in charge of maintenance of the power station; the factor which will cause very high maintenance of the feed-water pump has nothing to do with the induced-draft fans. Again, there is little relation between coal-handling equipment and feed-water heaters.

It is not practicable to alter the maintenance accounts, because they must conform to the division used by the public service commission. Separating of these accounts is not desirable, as it would add to the number to be kept in the general ledger. In order to overcome these objections, the writer uses a subsidiary maintenance ledger and a special sub-account system which is nothing but an adaptation of the job order system to the maintenance accounts.


THE UNITED ELECTRIC LIGHT AND POWER COMPANY

MAINTENANCE DEBITS AND CREDITS

ACCT. No. 222.12 ACCT. TITLE Maintenance Boilers and Furnaces

JOB No. R2221.23 JOB TITLE Stoker Outside Parts Boilers 61-63

| WEEK ENDING | DESCRIPTION | UNIT NO. | LABOR P.R. No. | LABOR TITLE | LABOR HRS. | LABOR RATE | LABOR AMOUNT | MATERIAL M & S No. | MATERIAL AMOUNT | SUNDRIES REF. | SUNDRIES AMOUNT | TOTAL AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |

*Fig. 1—This ledger sheet is used in three colors: White for sub-accounts with numbers of four digits, yellow for for five digits and blue for six digits*

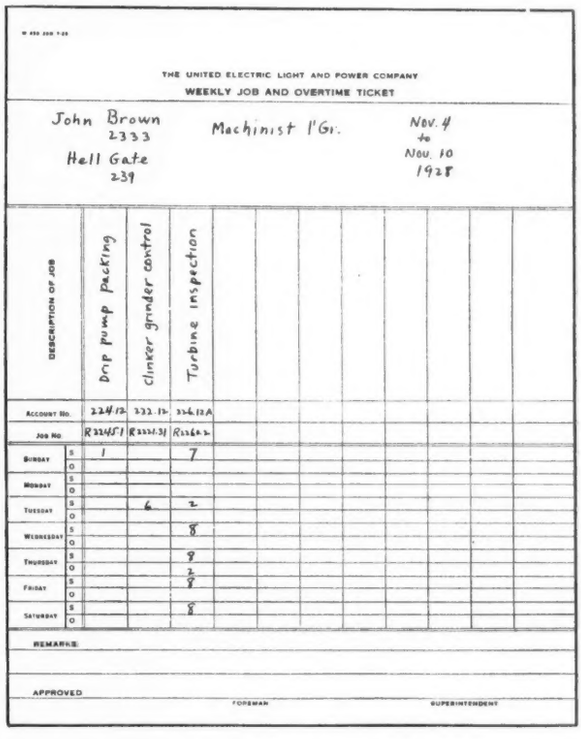
This subsidiary ledger is kept at the power plants because the figures contained therein are of interest to engineers only and the accounting department in the main office is not burdened by keeping a lot of records in which it has no direct interest. The information needs of the two departments differ markedly.

The "family tree" on the first page shows the split-up of account 222, which covers maintenance of boilers and brickwork. The success of such a system depends largely on the numbering scheme employed. It is important to make it as simple as possible, and it is also desirable to have each number serve as a description of the apparatus. Take the eighth account in the last column, for instance. Here R stands for Hell Gate power station. The first 2 stands for operation. The second 2 stands for maintenance and the third 2 for boilers and furnaces. The fourth figure, which is 1 in this case, stands for stokers. The fifth figure, which is 2, stands for outside stoker parts, and the sixth figure, which is 3, stands for a certain group of boilers (61 to 63). Each figure combined with its position gives the foreman the apparatus to which it applies.

This system has been in successful operation since 1925, and on account of the uniform numbering scheme there is no difficulty in remembering the sub-account numbers. Every foreman, however, has a chart in his office from which he can refresh his memory if necessary.

The "weekly job and overtime ticket" is shown in Fig. 2. The foreman is required to make a separate entry for each job or sub-account. A similar procedure is used in case of material, the storekeeper being required to charge the material to each job and not to an account, as was done before. As the first three figures of the job number are the account numbers, there is no difficulty in allocating the jobs to the proper account. The numbering scheme simplifies the task of grouping the charges because it is much easier to pick out the charges by the job number than to read each description.

Each sub-account has its own ledger sheet, as shown in Fig. 1. The charges are transferred from the time sheets to the column marked "labor." This column has


THE UNITED ELECTRIC LIGHT AND POWER COMPANY

WEEKLY JOB AND OVERTIME TICKET

John Brown 2333 — Machinist 1'Gr. — Nov. 4 to Nov. 10 1928

Hell Gate 239

| DESCRIPTION OF JOB | | Drip pump packing | Clinker grinder control | Turbine inspection |
|---|---|---|---|---|
| Account No. | | 224.12 | 222.13 | 226.12A |
| Job No. | | R2241.1 | R2221.31 | R2262.3 |
| Sunday | S | 1 | | 7 |
| | O | | | |
| Monday | S | | | |
| | O | | | |
| Tuesday | S | | 6 | 2 |
| | O | | | |
| Wednesday | S | | | 8 |
| | O | | | |
| Thursday | S | | | 9 |
| | O | | | 2 |
| Friday | S | | | 9 |
| | O | | | |
| Saturday | S | | | 8 |
| | O | | | |

REMARKS:

APPROVED

FOREMAN SUPERINTENDENT

*Fig. 2—Form of job ticket from which labor costs are assembled*

the following subdivisions: Payroll number of employee, his title, hours, and his rate. The clerk, when copying the data from the time sheets, computes the total amount from the first four subdivisions.

Similarly, material is put down in the material column where provision is made for reference to the storeroom requisition. A third column marked "Sundries" is used for charges that are neither labor nor material.

Usually, only one unit is worked on at a time, and for that reason there is little difficulty in marking in the unit column. For instance, if the men are working on the job R 2221.23, which is the maintenance of outside parts of the stokers on the sixth row of boilers, the foreman is supposed to mark on the slip the boiler that is being worked on. This number is put in the unit column.

Let us follow through the stoker maintenance. At the end of the month the account R 2221.23 is totaled. The total is then transferred to sub-account R 2221.2, which includes the maintenance of outside stoker parts of all the boilers. The total of the sub-account of R 2221.2 is in turn transferred to the sub-account of R 2221, which includes the maintenance of all stokers of all the boilers. The total of sub-account R 2221 is then transferred to the account 222, which is the official public service commission subdivision and appears on the main ledger.

In order to avoid confusion of sub-accounts, sheets of different colors are used. White sheets are used for sub-accounts with numbers of four digits, yellow sheets for five digits and blue sheets for six digits. These colors are indicated at the top of the "family tree" of account 222.

The main advantage of this numbering scheme, outside of its being logical and descriptive, is the fact that it can easily be separated to take care of the new equipment, or if it is at all necessary to provide a still more detailed division.

The forms are specially designed for engineering analysis. Experience has shown that this maintenance accounting system gives cost records that leave little to be desired. The writer was able to get a total for any division within a few minutes.

This system not only improved the cost record, but also reduced the burden of the clerical force at the stations. It is no longer necessary to decipher the hieroglyphics of various foremen, and the clerks need not be engaged in long research through past records when the maintenance cost of certain pieces of apparatus is called for. This system enables us to obtain on short notice practically any maintenance cost that can reasonably be demanded.

Maintenance costs are important because they enable us to determine the merits of various pieces of apparatus and help us in deciding on the purchase of new equipment. Another important advantage of this maintenance cost system is that it enables us to reduce the costs themselves by improving operation. Mere cost keeping is of little avail unless this cost carries a message. A well planned system tells the treasurer what expenditures he can expect in the future and it tells the engineers how they can reduce costs.


## *A Panorama of Power Services*

**In America everything industrial is moving forward. With a little more help from the radio engineers the very word "static" may soon come to have a strange and unfamiliar sound. Industrial progress goes hand in hand with constant modernization of the power services—and the power engineer, in turn, must forever move on in his thinking and practical knowledge.**

**Hence the need to get away, at intervals, from one's own special power-service set-up and survey leading examples of modern practice in other plants and other industries. The opportunity will be found in the Nov. 27 issue, where such services as electrical generation, air conditioning, ventilation, heating, compressed air, electricity, elevators, steam services and fire protection will be covered, not in the abstract, but in terms of outstanding applications.**

**Automobile factories, refrigerator plants, pumping stations, great stores and office buildings will appear as scenes of specific power services. In short the editors will spread before *Power* readers a panorama of the power services—1928 model.**

# Good Maintenance Methods

## Reduce Power Costs 30 Per Cent

**besides giving practically 100 per cent service where, before a regular maintenance schedule was adopted, the operation was subject to frequent interruptions**

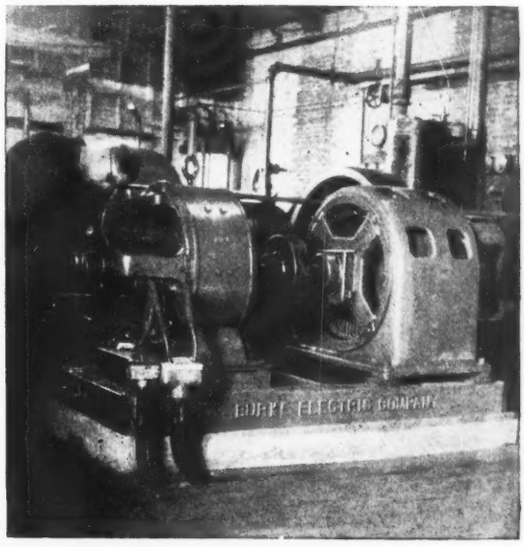


*Fig. 1—The motors and controllers are inspected every two weeks*

GOOD maintenance methods are the biggest dividend payers in any industrial process. There are many reasons. First, if the equipment is systematically inspected and looked after, the little faults will be detected and can be repaired at low cost before they develop into defects that cause unexpected and prolonged shutdowns and require expensive repairs. The cost of repairs may be only a small part of the expense involved in a shutdown. During the delay the loss in production may cost many times that of repairing the equipment. If the operation of equipment is uncertain, it tends to disorganize production methods and reduce output.

Equipment that is poorly maintained increases the power cost by leaks through faulty insulation, worn bearings, shafting and other parts out of line, tight belts, leaks in air and water lines, and other causes associated with improper attention to keeping machinery in good condition.

An excellent example of what can be accomplished by good maintenance methods is found in the plant of the Ramapo Ajax Company, Hillburn, N. Y., manufacturers of railroad track equipment. In this plant there are 350 motors ranging in size up to 100 hp. There are also thirteen cranes, the largest of which has a rating of fifteen tons. A large part of the power is distributed at 440 volts two-phase. For the cranes and some of the machine tools 230-volt direct current is provided through two motor-generator sets, each consisting of a 100-hp. synchronous motor driving a 250-volt direct-current generator.

Failures that required taking a motor out of service and sending it to a repair shop, used to be a weekly occurrence in this plant. Machines were out of service until the motor was repaired or replaced by a spare. Bearing failures were common and fuse blowing was an hourly happening. Starting with these conditions, by a gradual process of putting the equipment into good condition and properly maintaining it, motor failures have become an unknown quantity, less labor is required to take care of it and the power costs have been reduced about 30 per cent, or $1,000 a month.

To put the equipment in shape, a gradual process of overhauling was followed. When a motor or a crane could be conveniently taken out of service for a complete overhauling, it was taken apart, thoroughly cleaned and defective parts and insulation replaced. The motor windings were cleaned by scraping off the grease and dust that had collected and then washing the parts with benzine. The parts were then put into an electric oven and thoroughly dried, after which they were given a coat of insulating varnish by spraying and again baked. The job was completed by applying a second coat of varnish and a baking. The control equipment was also completely overhauled. Everything necessary was done to put the apparatus into first-class condition.

### Anti-Friction Bearings Used

On some of the motors whose bearings were not designed for the heavy loads they had to carry, sleeve bearings were replaced by an anti-friction type especially designed for the heavy loads. This change has eliminated bearing trouble in these severe conditions.

Along with putting the equipment into condition, a system of motor and control record cards was adopted. The two sides of these cards are shown in Fig. 2. In a file of these cards a record of each motor and its control equipment is maintained by the mechanical manager. From these records a check can be had at any time on how a motor has been performing, when it was last taken out of service for a complete overhauling, cleaning and varnishing, also the cost of making the repairs.

In addition to the card system the mechanical manager maintains a book that has a page for each motor. The information kept has chiefly to do with the service rec-

ord of the motor and it is convenient to carry this book around the plant for ready reference and for use in plant-operation conferences.

There are three electricians in the plant, one of whom makes the regular inspections. All motors are inspected twice a month. At these times the oiling is looked after. This consists chiefly of checking the movement of the oil rings, the height of the oil in the bearing, and the temperature. The inspector is provided with a set of long feelers with which to check the air gaps of the motors. When the bearings begin to show wear as indicated by an unequal air gap, they are reported to the mechanical manager, who arranges with the head of the department in which the motor is located for a time when the electricians can change the bearings without interfering with production. The electricians are given a written order to do the work, and when the work is finished the order is returned to the mechanical manager marked O.K. and signed by those doing the work. This order is then turned over to the inspector to check the motor's operation and ascertain if everything is satisfactory.

The inspector also cleans the motors and controllers, checks up on their general condition and makes any small repairs that can be made easily. If there is something to be done that requires taking the motor out of service, this is reported to the mechanical manager, who makes the necessary arrangements to have the electricians do the work.

On the direct-current machines the conditions of commutators and brushes are carefully checked. When new brushes are installed, the spring tension is measured with a scale to give each brush equal tension on the commutator. If brushes show equal wear, the tension is again checked and adjusted during regular inspection.

Under the old conditions, a great deal of trouble was experienced with excessive wear of the brushes and commutators. Flush mica was used in the commutator and abrasive brushes were necessary to wear the mica to prevent it from becoming high. This trouble has been overcome by undercutting the mica and using non-abraisive brushes. It is the inspector's job to clean the slots every two weeks so that dirt and oil do not become lodged in them and cause short circuits. Where the commutator and brushes are exposed to dirt and oil, they are protected by covers, as in Fig. 3. Any unevenness on the commutator is taken care of by a commutator stone. When the motor is taken out of service for a general cleaning and insulating, the commutator is trued in a lathe.

A high grade of lubricating oil is used in the motor bearings, and this is changed every three months and a record of the change is kept on the motor card. The oil is drawn from the bearings, and they are washed out with benzine before refilling. The oil taken from the motor bearings is filtered and used on lineshafts and other bearings where the service requirements are not so exacting as on the motors.

The motor inspector also checks up on the condition of lineshafting, hangers, and bearings and other power-transmitting equipment and does the oiling. Each crane operator is held responsible for oiling and keeping his crane clean. He is encouraged in this work by personal instructions and other means, such as promotion. The following is a set of the written instructions issued to each craneman:

1. Keep your crane clean.
2. When oiling, carry waste with you and wipe dirt and dust from around the oil cap before pouring oil in.
3. Be careful and do not fill the bearing so full that oil overflows, as this will ruin the motor's insulation.

| H P. | Syn. Speed | Make | Winding Diagram | Application | Shop or Mill No. | Card No. |
|---|---|---|---|---|---|---|

| Type | Frame | Poles | F. L. Speed | Volts | Form | Temp. Rating | F.L. Amp. | Phase | Cycles |
|---|---|---|---|---|---|---|---|---|---|

| | | |
|---|---|---|
| Serial No.<br>Model No. | Publication No. | CONTROL EQUIPMENT<br>Type Make Pub. No. |
| **BRUSHES**<br>No. Per Motor<br>Cat. No.<br>Size<br>Material<br>Grade | **COILS**<br>(Cat. or Spec. No.)<br>Stator or Field<br>Main<br>Comm.<br>Comp. | |
| **LININGS**<br>Front End, Cat. No.<br>Pulley End, Cat. No. | Rotor or Armature<br>Coils<br>Bars<br>No. per Set | Connection Diagram |
| **PULLEY**<br>Diam.<br>Face<br>Belt Width<br>Bore<br>Keyway | Mfr's Order No.<br>Our Order No.<br>Date of Order<br>Cost { Motor / Control | User:<br>Location: |
| REMARKS: | | |

THIS RECORD CARD FOR MOTOR USERS is recommended for stock and inventory, repair motor part, motor transfer, required power, service and similar records. Furnished by General Electric Company. SMD-39 50m 6-26-28

SERVICE RECORD

| Date | Building | Floor | Driving | Drive | Tested Hp. |
|---|---|---|---|---|---|
| | | | | | |

REPAIRS

| Date | Condition | Due to | Repaired by | Cost |
|---|---|---|---|---|
| | | | | |

*Fig. 2—The two sides of the motor and controller record card*

In a file of these cards a record is kept of each motor in the plant. These records are valuable, both when ordering parts and as a means of keeping track of the maintenance cost and service performance of the motors.

4. Keep your motors clean.

5. Do not allow oil and grease to collect on the carriage and trolley, as this is likely to cause a fire and burn the crane and building.

6. Don't run the crane or trolley against the stops or one crane against another.

7. Don't raise the lower block so high that the limit switch has to stop it.

8. Don't lift a load unless you can bring the hook plumb over it.

9. Don't drag loads; the crane is not a locomotive.

10. Don't lift overloads.

11. Don't carry loads over men without warning by ringing the bell.

12. Don't take risks.

13. Keep your crane clean.

In addition to the work done by the crane operator, the equipment is examined every two weeks by the regular inspector, who reports any defect that he cannot repair. These are repaired by the electrician, as are the major defects in the rest of the electrical equipment.

On the alternating-current motors the compensator contacts are inspected once a month. The oil tank is lowered, the necessary adjustments made on the contacts and the oil examined. Where compensators are in frequent use, the oil is changed every six months.

Under the old order of operation four electricians, working ten hours a day with frequent overtime, were

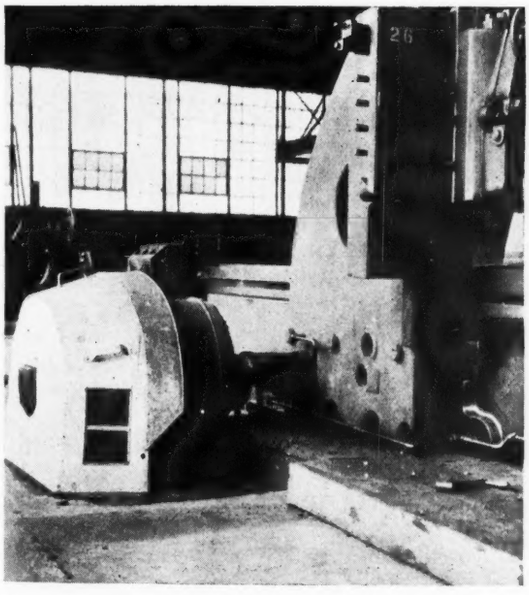


*Fig. 3—Where the commutators of direct-current motors are exposed to dirt and oil, they are protected as shown at the left*

required to take care of the electrical equipment and the cranes. Today only three men are required, one of whom is the inspector. These men work eight hours per day and seldom have overtime work.

In addition to obtaining practically 100 per cent service from the power equipment and reducing the labor to take care of it approximately 40 per cent, large savings in power have been made. These savings have been accomplished in many ways.

Inspection of the compressed-air equipment revealed many leaks in both the supply and utilizing apparatus. Two compressors were required to supply the air, one driven by a 100-hp. and another by a 50-hp. motor. Stopping the leaks has reduced the air requirements to where they can be supplied by the 50-hp. compressor.

Another large loss of power was in the lighting system. There are about three hundred 500-watt lamps in the plant. These lamps were wired so that all the lights in one department were on the same circuit and controlled

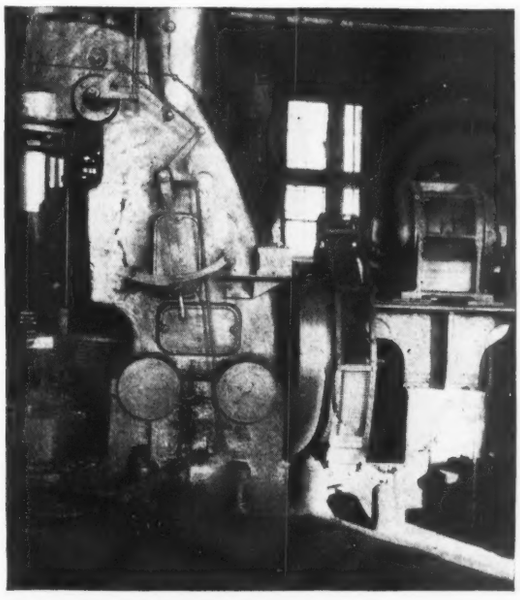


*Fig. 4—Motor-driven air trip-hammer*

This type of hammer is used to replace steam hammers and allowed eliminating a high-pressure boiler plant, which resulted in a large saving in operating cost.

by one switch. This required all lights in a department to be on when only one or two might be required. In some cases five kilowatts was used in the lighting circuit when one would have been sufficient at times. On part of the lights switches have been installed, so that each light can be controlled individually. On the remainder switches have been provided to control four or five that are required as a group. The use of white paint and keeping the windows and lamps clean have also contributed to the power saving. The lamps and reflectors are cleaned about once a month.

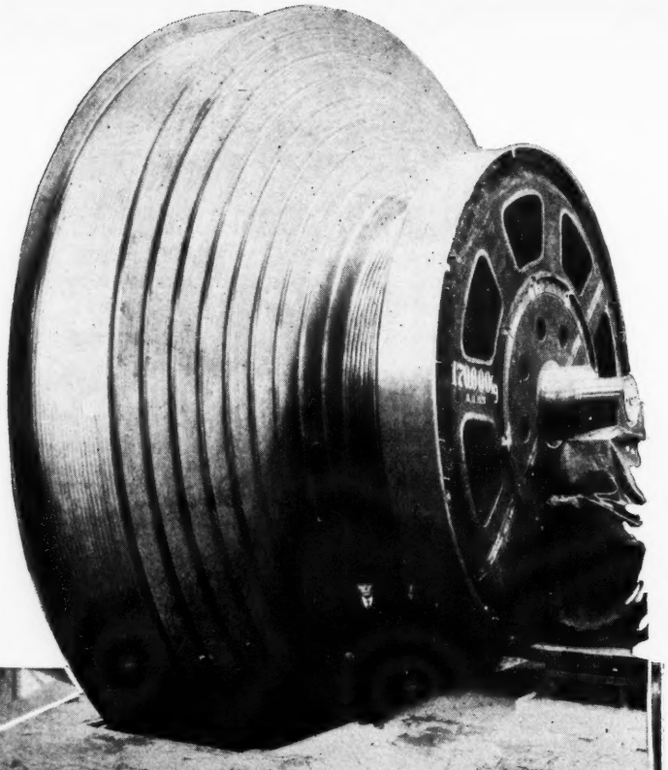
Rearranging the motors to have them more nearly fully loaded, the replacing of inefficient group drives by individual drives, the maintaining of belts, lineshafts and other mechanical power-transmission equipment in proper condition, and better upkeep of the electrical equipment have resulted in large power savings.

To supply the direct current to the crane and machine-tool motors, two 100-hp. motor-generator sets were required; now one takes care of the work. A lineshaft driven by a 100-hp. motor was required to run continuously, to operate machines used for intermittent service. By replacing this motor by individual drives, the power consumption is now only a small part of what it was before.

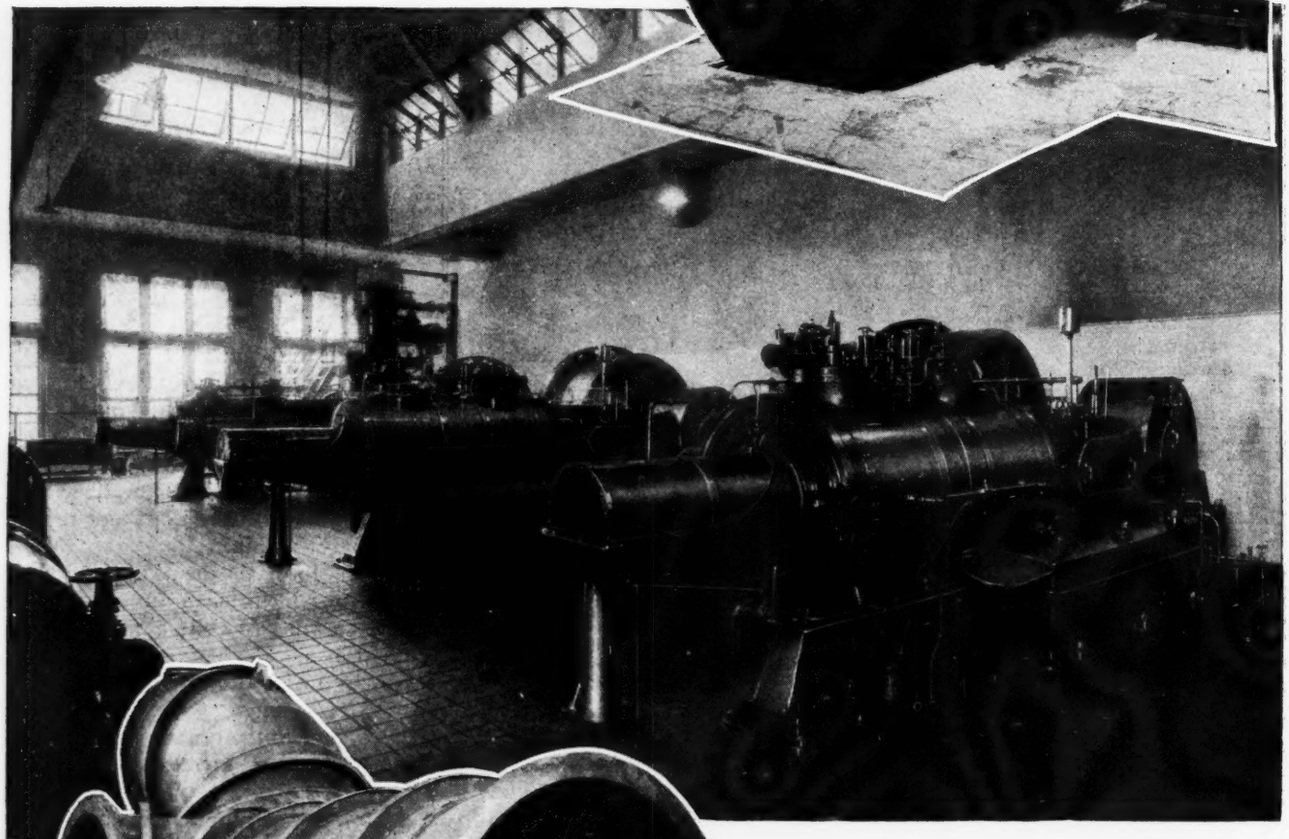
Attention is also given to training the workmen to shut down motors that are not required in service. There are other economies planned, but present changes, as previously mentioned, have reduced the power costs about $1,000 a month, greatly improved the service, increased output and reduced the unit cost.

For the information in this article *Power* is indebted to J. A. Storms, mechanical manager of the Ramapo Ajax Company plant at Hillburn, N. Y.

# BIG THINGS *in Power*



*Right: A hoist drum for a South African mine, from Skoda Works*



*Above: Three Skinner Unaflow engines in a factory plant*

*Left: A Westinghouse 7-ft. arc-welded steam header*

# The Relation Between Carbon Dioxide and Excess Air*

By A. A. Potter and H. L. Solberg

BECAUSE of dilution the effect of excess air is to decrease the percentage content of $CO_2$ in the products of combustion. Since the presence of this air in the products of combustion results in a loss due to the heat required to raise its temperature to the final temperature of the waste gases, the quantity of this excess air must be controlled within fairly narrow limits.

A number of automatic $CO_2$ recorders have been developed which are intended to give the operator a direct indication of the amount of excess air. Provided that combustion is complete, the dry products of combustion consist of $CO_2$, $SO_2$, $O_2$ and the $N_2$ which accompanies the free $O_2$ and the $O_2$ required for the combustion of the fuel. In all commercial analyses the $SO_2$ is absorbed as $CO_2$, but is present in such small quantities as to be negligible. Consequently, the dry products of combustion are considered to be composed of $CO_2$, $O_2$ and $N_2$. Excess air increases the $O_2$ and $N_2$ so that the percentage of $CO_2$ may be used as an indication of the amount of excess air present, provided that the percentage of $CO_2$ obtainable with perfect combustion and no excess air is known.

The percentage of $CO_2$ obtainable with perfect combustion depends upon the analysis of the fuel and can be calculated. It is a common opinion among engineers that 14 per cent $CO_2$ represents excellent combustion conditions. This is true in the case of bituminous coals if there are only small amounts of unburned gases in the products of combustion. On the other hand, it is impossible to burn some gaseous fuels and obtain 10 per cent $CO_2$ even assuming perfect combustion. The $CO_2$ obtainable with complete combustion without excess air, $CO_{2(max)}$, is a function of the kind of fuel and varies as is shown in Fig. 1, according to the formula:

$$(CO_2)_{max} = \frac{8.81}{0.421 + H_a/C} \text{ per cent}$$

Where $H_a$ = available hydrogen, $\left(H - \frac{O}{8}\right)$ by weight.

This formula is based on the assumption that the nitrogen in the products of combustion is supplied from the air. Consequently, the formula cannot be applied to fuels high in nitrogen, such as producer and blast-furnace gas. Practically all other fuels contain negligible amounts of nitrogen in comparison with the amount of nitrogen in the dry products of combustion.

Most commercial fuels contain some sulphur, but the resulting $SO_2$ in the products of combustion is generally negligible, seldom exceeding 0.4 per cent except in extreme cases. However, in the process of analyzing the products of combustion, the $SO_2$ is absorbed with $CO_2$ and increases the apparent $CO_2$ content of the gases. Since the ratio of the volumes of the products of combustion of one pound of carbon and sulphur is proportional to their molecular weights, $\frac{12}{32}$ or 0.375, the formula may be modified for high sulphur fuels as follows:

$$(CO_2)_{max} = \frac{8.81}{0.421 + \left(\frac{H_a}{C + 0.375S}\right)} \qquad (6)$$

*Example 1*—Calculate the $CO_2$ obtainable by the perfect combustion of coal having the following analysis: C, 70 per cent; H, 5 per cent; O, 8 per cent; N, 1 per cent; S, 2 per cent; moisture, 6 per cent; ash, 8 per cent.

Solution—

$$\frac{1}{\left(\frac{H_a}{C + 0.375S}\right)} = \frac{C + 0.375S}{H - O/8} = \frac{70 + 0.37 \times 2}{5 - 8/8} = 17.7$$

From Fig. 1 or Equation (6), $(CO_2)_{max}$ = 18.5 per cent.

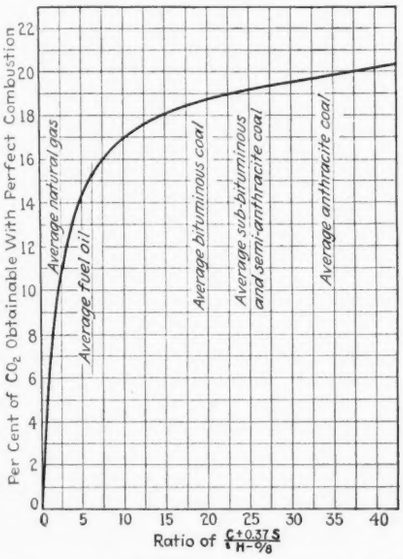

Per Cent of $CO_2$ Obtainable With Perfect Combustion
Average natural gas
Average fuel oil
Average bituminous coal
Average sub-bituminous and semi-anthracite coal
Average anthracite coal
Ratio of $\frac{C+0.375S}{H-O/8}$

*Fig. 1—Maximum percentage of $CO_2$ obtainable with perfect combustion*

This curve is not applicable to fuels high in nitrogen, such as blast-furnace gas.

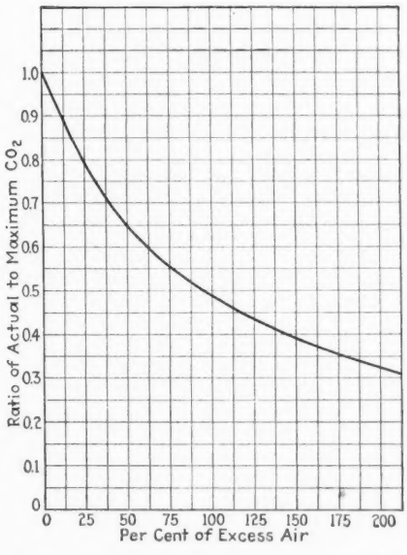



*Fig. 2—Effect of excess air on $CO_2$ obtainable with complete combustion*

This curve does not apply to fuels that are high in nitrogen.

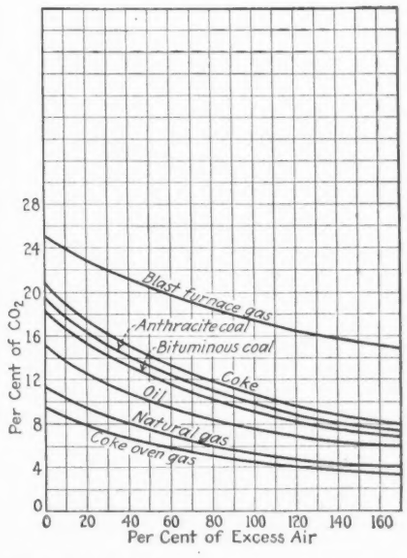



*Fig. 3—Relation between excess air and $CO_2$ for representative fuels*

These curves apply to specific fuels and are not general.

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In the case of gaseous fuels, the analyses are reported on a volumetric basis and the maximum $CO_2$ obtainable with perfect combustion can be calculated from the following formula:

$$(CO_2)_{max} = \frac{CO_2+CO+CH_4+2(C_3H_6+C_2H_4+C_2H_2)}{N_2+CO_2+2.89CO+1.89H_2+8.56CH_4+15.23C_2H_6+13.34C_2H_4+11.45C_2H_2-4O_2}$$

where $N_2$, $CO_2$, CO, $CH_4$, etc., are the percentages by volume of each constituent in the fuel gas. This equation is applicable to all kinds of gaseous fuels.

*Example 2*—Calculate the maximum $CO_2$ obtainable by perfect combustion of a gas having the following composition: $H_2$, 50 per cent; $CH_4$, 36 per cent; $C_2H_4$, 4 per cent; CO, 6 per cent; $N_2$, 2 per cent; 0, 0.5 per cent; $CO_2$, 1.5 per cent.

*Solution*—

$$(CO_2)_{max} = \frac{1.5+6+36+2\times4}{2+1.5+2.89\times6+1.89\times50+8.56\times36+13.34\times4-4\times0.5} = 10.8\%$$

Fig. 2 shows the dilutent effect of excess air upon the $CO_2$ obtainable with complete combustion. Thus, with 50 per cent of excess air, the $CO_2$ is only 65 per cent of $CO_{2(max)}$, while with 100 per cent of excess air the $CO_2$ is only 49 per cent of that obtainable with theoretically perfect combustion. Since $CO_{2(max)}$ is a definite quantity for any given fuel and can be determined when the analysis of the fuel is known, the actual $CO_2$ in the products of combustion can be used as a measure of the percentage of excess air supplied for combustion, provided combustion is practically complete. Free oxygen can also be used as a measure of the excess air supplied, since it is zero with theoretically perfect combustion and increases with the excess air. However, the $CO_2$ can be determined easily and a number of instruments are on the market for doing this automatically so that the percentage of $CO_2$ present in the dry products of combustion is generally used in regulating the combustion of fuels under steam boilers and in other applications.

High $CO_2$ does not necessarily mean efficient combustion, since a considerable quantity of unburned gases may escape if the air supply is restricted too much. Consequently, a complete analysis of the dry products of combustion should be made occasionally to prevent the loss of heat due to unburned gases caused by an excessive restriction of the air supply. Fig. 3 illustrates the ratio between excess air and $CO_2$ for several fuels.

## Relative Abrasion Resistance of Metals

RECENT investigations by J. M. Blake, engineer of tests, American Manganese Steel Company, Chicago Heights, Illinois, as reported in the proceedings of the A.S.T.M., regarding the relative resistance of various metals to abrasive action of wet grinding has shown that each abrasive or mineral substance develops its own order of relative abrasion resistance for metals, and that the position of any steel or alloy on a listing of abrasion factors will depend upon the nature of abrasive employed. In extreme cases it has been shown that steels at the top of the list with one abrasive may be at the bottom of the list with another. This discovery has eliminated the idea of securing general, all-around high abrasive resistance in any one steel and has enabled the development of alloys specifically adapted to particular field requirements.

The resistance of various steels to the abrasive action of wet sand is compared in the following table, in which a standard specimen of commercially pure iron is considered as 100.

| | |
|---|---|
| Standard specimen (commercially pure iron) | 100 |
| Merchant bar iron, annealed | 92 |
| White iron | 88 |
| Manganese steel | 77 |
| Tool steel, hardened | 76 |
| White iron, chilled | 72 |
| High-speed metal, hardened | 57 |
| Stellite (welded wearing face) | 51 |
| Amsco alloy, No. 459 (welded wearing face) | 31 |
| Amsco alloy, No. 459 (as cast) | 10 |

This method of comparing the abrasive resistance of various metals is substantially independent of time, pressure and speed, as it lists the unknown in terms of comparative performance of a material whose qualities are well known.

## Pipe Coil Reduces Temperature of Heating System Returns

By G. H. Kimball

MANY vacuum heating system employing steam pumps have difficulty in maintaining a vacuum as high as four inches after the temperature of the returns rises to 150 deg. or more. When this temperature is reached, the condition is frequently remedied by spraying cold water into the return line and so reducing the average return temperature.

If makeup water is needed, the use of the spray is warranted both for the additional water that it supplies and the effect on the vacuum pump. In cases where little, if any, makeup is required, this method of cooling the returns is wasteful of heat and water.

In one case where spray water was being used, a considerable amount of water was regularly lost to the sewer from the overflow of the return tank.

In order to stop this waste and also to furnish more heat to the basement space, several coils were made and hung horizontally from the ceiling. These were connected in series with the returns from the radiators in the upper floors. A bypass was provided for each coil in case it should become necessary or desirable to cut it out of service.

As most basements are less exposed to the cold than the upper floors, this hot-water radiation was amply sufficient, and it automatically varied with the outside temperature, since on cold days more radiation would be in service discharging warmer returns, while on warm days the returns were cooler. By the use of these coils the temperature of the returns was lowered to a point where the use of the spray was unnecessary.

This arrangement, it is believed, brought about a considerable saving. The improved vacuum that was made possible has resulted in the more efficient operation of the heating system, and the heat in the water formerly lost to the sewer is now put to a useful purpose in heating the basement.

[The method used by the author of this article to reduce the temperature of the returns from his heating system is interesting, but the installation of pipe coils for this purpose is only justified by the need of heat in the basement. Under other circumstances it would be more economical to find and remedy the cause for the high-temperature returns, one of which is leaky radiator traps. Editor.]

# HIGH RATINGS—NO EROSION

## *In Boiler-Furnace Tests*

# AT CARBORUNDUM PLANT

Describes tests of pulverized-coal furnace in which the water walls are faced with Carbofrax blocks. Boiler ratings of 500 per cent, with combustion rates as high as 50,000 B.t.u. have been attained without any erosion of the refractory facing.

IN THE spring of 1927 the officials of The Carborundum Company came to the conclusion that the increasing demand for steam for process and heating in their Niagara Falls plant made necessary a modernization and increase in capacity of their boiler plant.

Consideration was given to both bent-tube and straight-tube boilers, and to pulverized-coal and stoker firing, followed by a decision to install three 5,000-sq.ft. Erie City three-drum boilers and Unitype pulverizers, with Seymour refractory-covered water-cooled furnaces of the basket-furnace type.

Reliability and flexibility were the two major factors involved in the choice of these furnaces, the water-cooled refractories affording an unusually durable construction and the refractory-lined furnace permitting satisfactory operation over the wide load range demanded by the operating conditions.

Vertical firing was adopted, because of its inherent symmetry with bent-tube boilers, and three Erie City Unitype pulverizers, each of 4,500 lb.-per-hour capacity and each supplying two Erie City curtain burners. Natural draft was provided, the brick stack being 200 ft. high.

Auxiliary equipment includes a Permutit water-softening system, the feed makeup being taken from the city mains, a Cochrane deaërating feed-water heater, two Buffalo Pump Company centrifugal feed pumps (one driven by a Terry turbine and the other being a reserve unit driven by motor) and a Jeffrey traveling weigh hopper for weighing the coal from the catenary bunker to the pulverizer hoppers. A dragline and scraper delivers coal from yard storage to the pit of a bucket elevator and conveyor, which distributes the coal along the catenary bunker, running the full length of the boiler room. The conveyor returns below the boiler-room floor, taking ashes from the dump pit to discharge into cars, the same arrangement also taking care of the distribution of coal to be unloaded directly from cars into the bunker.

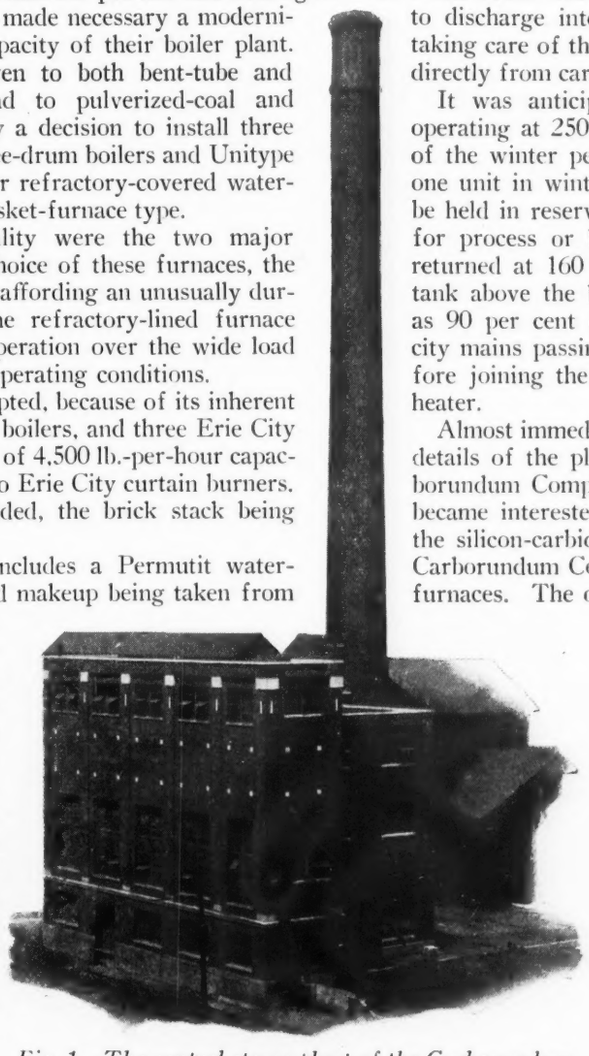


*Fig. 1—The central steam plant of the Carborundum Company, Niagara Falls, N. Y.*

It was anticipated that two 5,000-sq.ft. boilers operating at 250 per cent of rating would take care of the winter peaks in the steam demand, and that one unit in winter and two units in summer would be held in reserve. As the steam is nearly all used for process or building heating, the condensate is returned at 160 deg. to 180 deg. F. to a reservoir tank above the boilers, and may constitute as high as 90 per cent of the feed, the makeup from the city mains passing through the Permutit system before joining the condensate entering the deaërating heater.

Almost immediately after the decision on the major details of the plant had been made, both The Carborundum Company and the Erie City Iron Works became interested in the possibilities of Carbofrax, the silicon-carbide refractory manufactured by The Carborundum Company, as a lining for the Seymour furnaces. The opportunity to reduce to practice the study and theories of both technical organizations on high-speed furnace design was so logical and appealing that it was decided to experiment with the third unit, modifying the design to permit operation at high boiler and furnace ratings.

As the steam pressure carried was 150 lb. or less, the question arose as to what rating the boiler could be reasonably expected to reach without priming. No information being available on this subject, it was decided to design the remainder of the equipment for 500 per cent boiler rating, and then to carry the ratings

under test conditions as high as the functioning of the boiler and furnace would permit.

The new requirements called for induced-draft fan and forced-draft turbulent firing, a second pulverizer of equal capacity, a revision of the water-wall design to take care of the greatly increased rate of circulation, revision of the air-cooled front-wall design to suit the characteristics of Carbofrax, and necessitated air cooling and Carbofrax facing for the bridge wall. Fans and pressure air ducts were required, as well as a novel design of burner.

The matter of using horizontal burners was considered, but the appropriateness to bent-tube boilers of vertical firing through the arch was so marked that it was decided to retain that type of firing and proceed to develop a burner that would be adapted to the special conditions imposed.

The general requirements having been outlined, an engineering problem of no mean proportions remained. Here was a standard boiler, operating at comparatively low pressure, and it was proposed to increase total evaporation to nearly twice its best previous performance. The boiler design had already been refined to the utmost in pursuit of dry steam, leaving no recourse but to try and see what it would do. But in addition it was proposed to connect to it the circulation of a water-wall furnace, offering many opportunities for upsetting the normal boiler circulation. The furnace itself was planned to operate at a heat release considerably beyond anything existing in reported commercial practice, and finally it remained to devise a burner, firing through the arch, which would permit of a heat release appreciably beyond anything that had so far been attempted in furnaces of this size.

The first problem was to provide a free circulation for the furnace without interfering with the circulation of the three-drum boiler or disturbing its water levels. That this was successfully accomplished is evidenced by the results described herein and by the fact that no changes of any kind in the circulation system have been found necessary.

The original burners incorporated in the layout were of the standard curtain type, which have been used successfully on many ordinary high-rating installations operating under natural or induced draft. Some minor modifications were made in the details and arrangement of the burners, but these later proved to be insufficient, and a variation was introduced in the burner arrangement to increase the effective operating range. No further modifications were found necessary, as the one revision removed the limit to burner operation and no new limit to the performance range of the burners in their present form has yet been discovered.

The furnace itself was held to the same dimensions as in the first two units, which were of standard construction throughout. The original tube spacing was also maintained. The design of the refractory blocks was revised, however, to take advantage of the structural strength of Carbofrax, considerable unnecessary weight and thickness being eliminated. In the assembly of these blocks no mortar or cement of any sort is used between the blocks and tubes, or between the blocks themselves. The construction is comparatively inexpensive and simple to assemble. Only three shapes are required for the

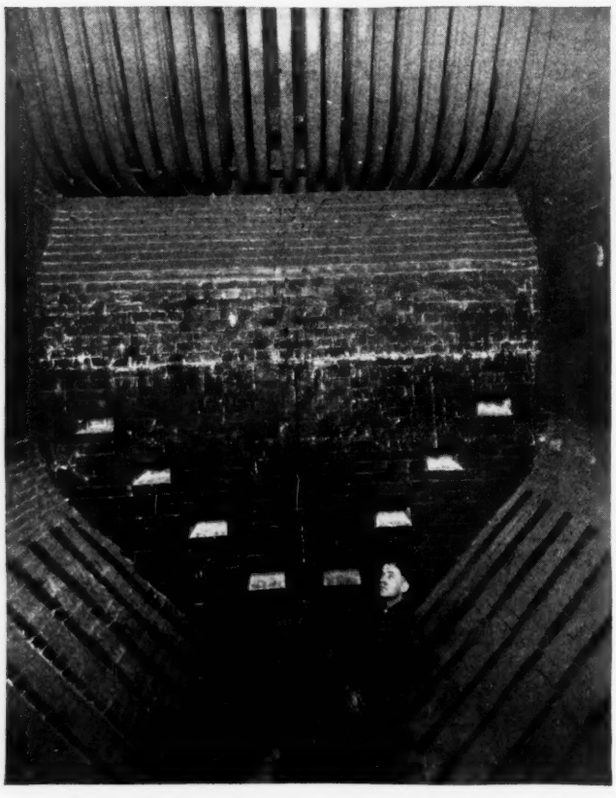


*Fig. 2—Interior of furnace, showing water-cooled furnace walls and bottom, air-cooled bridge wall and front bank of boiler tubes*

*Fig. 3—Removal of slag after six months' operation at high ratings shows absence of slag penetration in refractory facing of the water wall*

water wall, one for the straight sections, and one each for the concave and convex curves in the water wall.

Design, fabrication and installation of the equipment having been completed, instruments and equipment were installed to measure temperatures at a large number of points in the refractories in both water- and air-cooled sections, and gas temperatures throughout the setting. Pressure and draft gages were attached wherever the readings would be of interest, and weigh tanks, steam calorimeter and other paraphernalia required to run accurate boiler tests were provided.

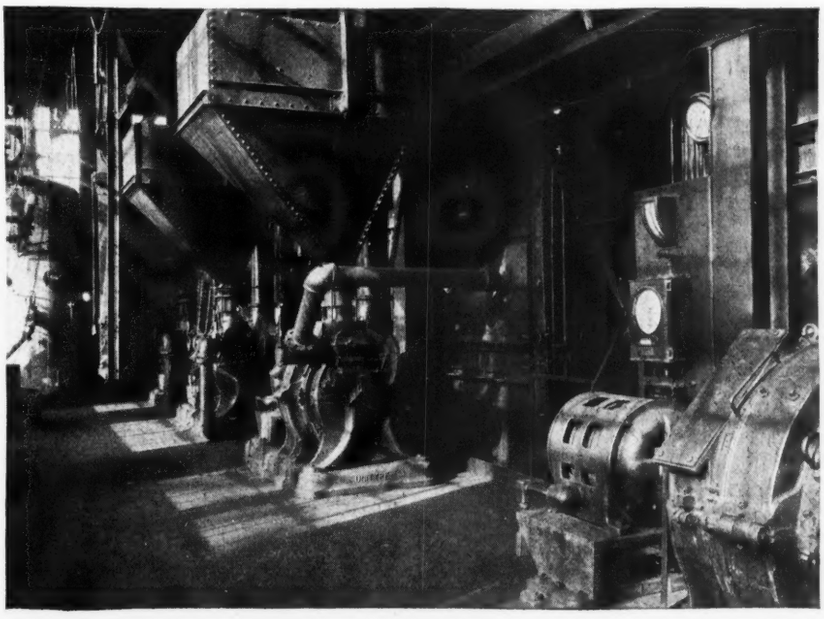


*Fig. 4—General view of firing floor, showing the Unitype pulverizers, fronts of the Seymour Carbofrax furnaces, coal handling, weigh larry, etc. The basket-type furnaces are set under 5,000 sq.ft. three-drum Erie City boilers.*

This unit was put into service in April, 1928. Since that time a series of tests have been conducted to measure performance. A large mass of data has been collected and is being prepared for publication. In the meantime, it is interesting to note the following facts: The boiler rating was gradually increased from about 100 per cent to over 500 per cent, the limiting factor being the capacity of the auxiliary equipment. Even at the higher ratings, it was easy to maintain from 14 per cent to 16 per cent $CO_2$ in the furnace. At the lower rating the heat release dropped to 10,000 B.t.u. per cubic foot without hindering combustion or producing smoke. Although the heat release climbed above 50,000 B.t.u. at the highest rating, the smoke condition remained well within the requirements of smoke ordinances.

Over this entire range of operation, and even with the high thermal conductivity of the furnace walls and the sudden load changes, the water level in the boiler remained undisturbed and the high quality of the steam unchanged. The improved powdered-coal burners met the exacting demands with ease, and the ash came down in a loose or friable condition.

The unit has been turned over to the plant operating personnel for general service, and it is expected that further valuable data on high-rating performance will be available from the daily records.

The purpose of the tests was to make observations on the behavior of the whole unit over a very wide operating range under known conditions, with special reference to the functioning of the refractories and the burners, and the boiler performance at very high ratings. It was proposed to make such corrections in the design of details during the tests as might be required by the unusually severe conditions which the unit was to undergo, but it turned out that the only corrections needed were the modifications that have already been mentioned.

In every respect the refractory performed fully up to expectation. It took a thin coating of porous slag almost immediately, which served as a perfect protective covering at all ratings within the range of operation attempted. Upon several occasions sheets of slag were peeled off the wall at different points, to permit examination of the Carbofrax beneath. In every case the refractory showed a clean undamaged face, the slag coming away like a husk and leaving no evidence of the slightest effect upon the integrity of the refractory.

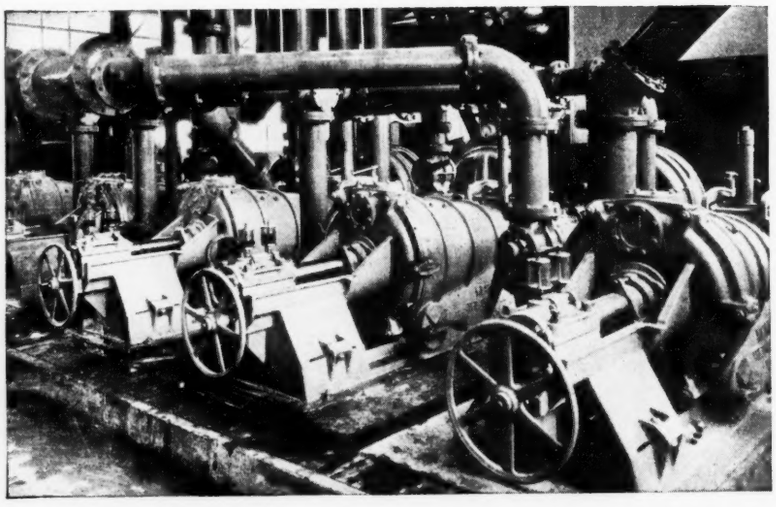
The refractory, moreover, admirably performed the function of keeping the furnace hot enough to provide excellent combustion conditions over a wide range of ratings, while at the same time absorbing heat rapidly enough to maintain reasonable furnace temperatures and prevent the formation of hard slag in the ashpit. A large part of the ash was of the consistency of coarse sand, and the remainder in friable lumps that broke down to small pieces in handling.

The performance of the boiler was equally satisfactory, the quality of the steam being better than 99 per cent dry at ratings over 500 per cent. Water-level glasses were fitted to both front and rear drums, and showed a steady water level at both points, regardless of the rating.

The burners, in their final form, required no further attention throughout the tests and demonstrated flexibility in following loads that fluctuated rapidly.

The unit as a whole appeared to be well within its peak capacity when operating at the highest ratings attempted, the limitations to performance being set by the designed capacity of auxiliary equipment and details, rather than by the refractory-lined water wall, the burners or the boiler. Heat releases of from less than 10,000 to over 50,000 B.t.u. per cubic foot of furnace volume offered no difficulties in operation, and no sign of deterioration in the furnace has yet developed.

# BALANCING POWER *and* HEAT *In a Paper Mill*



*Typical battery of motor-driven jordan engines*

By W. T. Miller
*Mechanical Engineer*

Better use of byproduct heat and power should be a major objective of the power engineer in every process industry. This study of the heat-power balance in paper mills is a good approach to the solution of similar problems in other fields.

THERE are few industries in which there is the closely interwoven relationship among power, steam and product that is found in the manufacture of paper. Continuous pumping of water sufficient to supply a fair-sized city is quite the common thing; the water used often exceeds the total consumption of the community in which the mill is situated. An uninterrupted supply of steam and power is essential in the production of paper. The demand for water, both hot and cold, the demand for power in various forms and the demand for steam of various pressures make the application of a heat balance an interesting problem in paper mills.

In paper-board mills, of which this article treats, it is common practice to base operation figures on a per ton production basis. This practice, while satisfactory from a managerial point of view, is misleading to the engineer because in most mills production is governed to a great extent by the grade of paper made, and quite often the grade that lowers production requires the most power to produce.

The manufacture of test board of a certain weight and test is the example chosen for discussion in this article. The figures given are the average of several actual results obtained in representative mills by the author, but it is not the purpose of this article to set them up as a standard.

While this article is concerned with power and heat requirements rather than the technique of paper manufacture, a brief outline of the process will be given for the benefit of readers in other industries.

The raw materials used in the manufacture of test board consist of paper stock, or waste paper, and kraft pulp, supplemented by waterproofing size and neutralizing agents. These materials are mixed with hot water and beaten into a pulp in beating engines and dropped into stock chests. The stock in the chests is continually agitated until pumped to jordan engines where the pulp is rubbed and ground until each fiber is separated from its fellows and is of proper length for arrangement into a sheet of paper.

The stock is again agitated in chests until it is pumped through a stuff box, diluted with water and poured on screens. The screens are made up of several finely slotted plates with cam-actuated diaphragms below them. The suction created by the diaphragms draws the stock through the slots, leaving the coarse bits and foreign materials on top of the plates. The stock flows from the screens into mixing vats, where it is diluted with water until it reaches a consistency of about one-half of one per cent stock and 99½ per cent water.

The stock mixture then flows into cylinder vats, where the stock is strained from the water by revolving cylinders covered with a fine-mesh screen wire. As the cylinder revolves, the strained stock is pressed and transferred to the underside of a continuous belt of soft woolen fabric or felt. The felt with the sheet of raw paper adhering to it reverses its direction over a drum roll, meets and is covered with another felt, passes over devices which remove surplus water by means of vacuum, and finally passes between a series of rolls which squeeze and press the water out without crushing the sheet.

From the presses the sheet passes onto, and is dried by, a series of revolving driers, which are hollow cylindrical drums with steam circulated on the inside. An interesting feature of the drying process is created by the fact that as the sheet dries it shrinks. For this reason it is necessary to have the driers driven in sections with the speed of these sections graduated so as to compensate for the shrinkage.

When dry the sheet is passed through calender rolls where it is given a surface finish by the ironing effect of the rolls rubbing the sheet, and is then wound on a reel. From the reel the sheet is run through slitters which trim it to the desired width. The slit sheets are then rewound into neat rolls of any required diameter.

The greatest demand for power in a board mill comes from the beater room, where the stock is prepared for manufacture into a sheet. The breaker beaters and finishing beaters consume 183 hp. in the production of one ton (2,000 lb.) of stock, and the jordan engines require 193 hp. The pumping and agitating add 22 hp. more, making a total of 398 hp. demand from this department in order to produce stock for one ton of paper. Strictly speaking, this is the horsepower per ton per hour, or the horsepower hours per ton.

In the manufacturing department, or machine room as it is commonly called, the screens require 10 hp. and the circulating pumps and vacuum pump serving the suction devices require 43 hp., making a total demand for constant-speed power of 53 hp. The variable-speed demand, which consists of the press, drier, calender, reel, slitter and rewinder drives, amounts to 58 horsepower.

The mill pumps and miscellaneous equipment, including power-plant auxiliaries, require a supply of 57 hp., making a grand total of 566 mechanical horsepower necessary to produce one ton of finished paper.

Hot water is supplied to the beater room and aids in disintegrating the stock. It requires 41,340 lb. of water at a temperature of 150 deg. F. for each ton of stock. Cold water is added at the chests and stuff box to the amount of 23,080 lb. Felt cleaners and showers demand 53,200 lb. of cold water, while power plant, fire protection and other fresh water needs, raise the total additional 2,933 lb. Thus the enormous demand for water is explained and it is realized that a supply of 120,553 lb. of water is necessary to make one ton of paper.

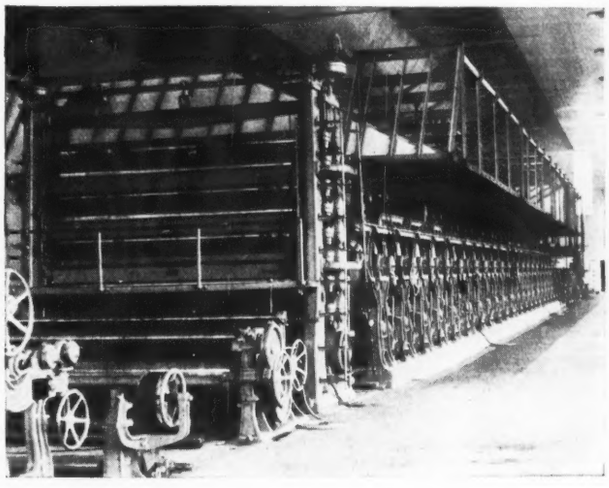
When the nature of the water permits, the felt shower water and vat overflow is reclaimed as "white water" and used for dilution purposes at the chests and stuff box. The circulating pumps which recirculate the vat water are called upon to handle 400,000 lb. of water for each ton of paper made. As the total head is quite low, the power consumption of these pumps is not so great as the quantity of water handled would indicate.

At least three stages of steam pressure are necessary for the manufacture of paper: High pressure for the prime movers, pumps, auxiliaries, felt cleaners and showers; intermediate pressure for drying; low pressure for water heating.

It is desirable to have the beater-room load divided between two power units, one of which exhausts into a low-pressure system along with the pumps and auxiliaries, while the other runs condensing. If 103 hp. of the total beater room load of 398 hp. per ton of paper were supplied by a noncondensing unit exhausting into the low-pressure system, enough steam would be available to meet the water-heating requirements. The initial temperature of the water may be raised to 80 deg. F. by diverting it through the condenser of the condensing power unit. With this arrangement, and assuming the power to be supplied by reciprocating units, the quota of live steam per ton of paper would be apportioned as 3,100 lb. to the non-condensing beater drive exhausting at low pressure, 5,460 lb. to the condensing beater drive, 1,392 lb. to the pumps and power-plant auxiliaries exhausting at low pressure, 3,745 lb. to the constant-speed and variable-speed machine-room drives exhausting at intermediate pressure, and 1,240 lb. to felt cleaners, showers, oil-separator discharge, boiler blowdown, etc., which constitute the boiler feed-water makeup. A total of 14,937 lb. of steam is necessary to convert raw materials into a ton of finished paper.

The heating of beater and boiler-feed water creates a demand of 5,910 lb. of low-pressure steam for each ton of paper. Drying requires the use of steam at intermediate pressure. As the sheet leaves the presses and passes onto the driers, it is 62 per cent water based on the wet weight, and as it leaves the driers it is 5 per cent water based on the dry weight, making it necessary to evaporate 3,110 lb. of water for each ton of paper during the drying process.

Theoretically, this requires 2.03 lb. of steam at 15 lb. gage pressure per pound of paper by utilizing re-evaporated steam from the condensate and discharging finally at atmospheric pressure. However, in actual practice the use of 2.63 lb. of steam per pound of paper is seldom bettered. Using the latter figure, it is necessary to supply the equivalent of 5,260 lb. of steam at 15 lb. gage pressure to dry one ton of product. The exhaust from the units driving the machine-room equipment is generally utilized for this purpose. However, if the equipment is in proper condition and is properly designed, it is necessary to supplement the supply of heat furnished by the exhaust of the driving units either with live-steam makeup or with heat recovered by means of air economizers from the heated vapor coming from the drying sheet and applied in the form of hot dry air to act as a dehumidifier. It is practical to recover as much as 10 per cent of the total demand in this manner.



*Machine-room view, showing drier section, calender and reel*

## A Game of Skill

There is no limit to the number of possible heat-power balances. But a study of fundamentals and specific applications will develop the skill to solve any practical problem of this sort that may arise.

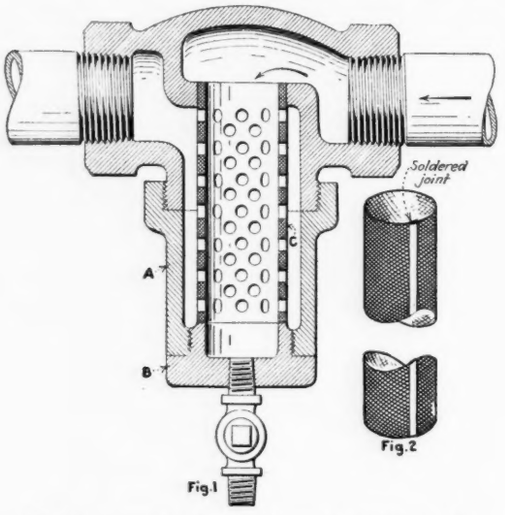
# *Right Out of the Plant*

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

## Improvised Light-Duty Strainer

THE usual power-plant scrap pile plus a little imagination or ingenuity will frequently help greatly in time of need. One result of such a combination is the light-duty strainer illustrated, that I made some time ago for placing in air, water and oil lines.

Its principal part is the body of a discarded globe valve. The additional parts *A* and *B* are made of brass




*Strainer made from discarded globe valve*

and provided with a clean-out cock as shown. A fine-mesh strainer, Fig. 2, with a soldered joint is made a neat fit inside the strainer casing. E. J. JORDAN.

Long Beach, Calif.

## Some Causes for the Failure of Fusible Plugs

THE failure of fusible plugs other than by melting, due to lack of water, is often brought about by the failure of the plug from corrosion, this usually taking place on the fire side. Normally, the flue gases should not be corrosive at this point owing to lack of moisture, but a slight water leak past the plug will render them active and highly corrosive. In one instance a fusible plug failed after eighteen months' service, the thread being severed from the bottom of the base.

The plug was heavily scaled on the water side, but the surface underneath was found to be uncorroded, while on the flue side the plug was deeply corroded, and a deposit of coppery hue was present. On analysis this deposit was found to consist of 12.6 per cent copper carbonate, 44.1 per cent copper sulphate, 20.1 per cent zinc sulphate and some further solid matter from the feed water, this having a slight acid reaction. On the plug being cut in half, a crack was found which permitted water leakage; this had rendered the flue gases corrosive, which, together with solids from the feed water, had caused corrosion and failure.

In another instance a fusible plug failed, the corrosion being confined to the screw threads; this was thought to be due to the alkaline reaction of the boiler water and to electrolytic action owing to the gun metal plug being in contact with the steel furnace crown.

A white deposit was also found which, on analysis, proved to be white lead. No white lead had been used in making the joint, only a graphite compound.

As the gun-metal plug contained a high percentage of lead and the water contained sodium carbonate which would attack the metal of the plug, the corrosion would form insoluble white lead, which would account for the white lead formed. A slight water leak had probably occurred due to corrosion or a badly fitting plug. It is therefore of importance that, should a plug be thought to leak, however slightly, it should be removed and examined at the earliest opportunity; otherwise the threads may be eaten away.

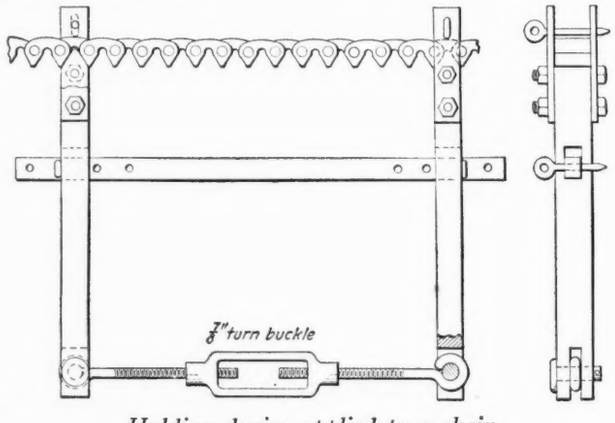
The fusible core should be removed for examination at each annual inspection and the entire plug each alternate year. The metal of the plug should be suitable to withstand the action of the feed water, and feed water with a highly alkaline reaction should be avoided on account of its possible action on the plug.

Brentford, England. W. E. WARNER.

## Device for Holding Silent Chain Taut While Replacing Links

THE illustration shows a little device we recently made to facilitate the replacement of links in silent chain drives, of which there are many in our plant.

The work of removing a full link from a chain and inserting a half link on chains below three inches in width




*Holding device applied to a chain*

is not difficult, but on chains over three inches, especially if the distance between sprockets is considerable, the ends of the chain cannot be readily held up on the sprocket while inserting the liners and pins, and not infrequently the sprockets are inaccessible for this work.

The device illustrated permits the work to be done on the run of the chain between the sprockets and in a minimum of time. The sketch is self-explanatory. One

end of each bar is made to fit into the chain link and is held in place by a pin inserted across the top of the chain. When the bars are in position, the slack in the chain is taken up by the turnbuckle with the center bar and pins providing a fulcrum for the end pieces.

Philadelphia, Pa. E. B. WEST.

## Quick Repair Made on Large Generator Core

QUICK repairs were made on a 3,000-kva. 2,300-volt hydro-electric generator that had a number of coils and its core damaged by a lightning discharge. A hole about 1½x4 in. was burned about halfway between the two ends of the stator core and the laminations were welded together.

The stator was made in halves, therefore it would require a complete rewinding of one-half of the machine if the core iron were restacked to replace the damaged section. This would have been a long and expensive job, so it was decided to remove the coils around the damaged section for a width equal to the length of one

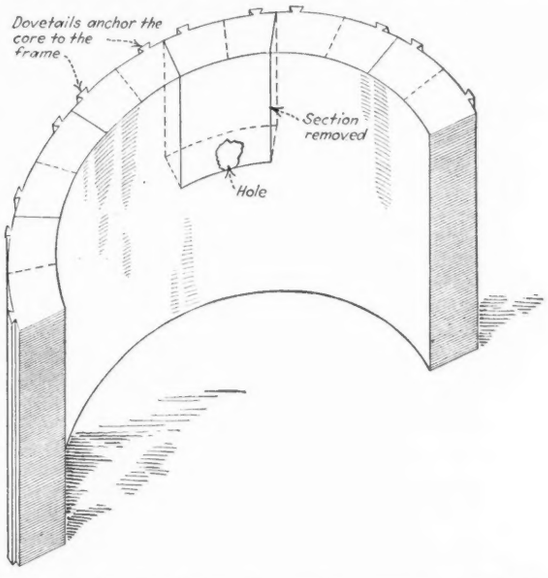



*Diagram showing how the section was renewed from the laminated core*

The slots have been omitted from the inside of the core to simplify the diagram

lamination. After this was done, the laminations were cut down and removed until the burned section was removed.

The laminations are 30 in. long and each is held to the stator frame by two dovetails. A section 30 in. long was removed from the core, as shown in the figure. The laminations overlapped one-half, so that one 30-in. section could be removed whole, and the two half-sections were cut off, after which another 30-in. section could be lifted out. This process was continued until the hole extended below the damaged laminations. The ends of the lamination at the two sides of the hole were carefully filed to a smooth surface, which was then painted. The hole was then stacked full of 30-in. laminations. New coils were used to replace the damaged one and then the machine was reassembled.

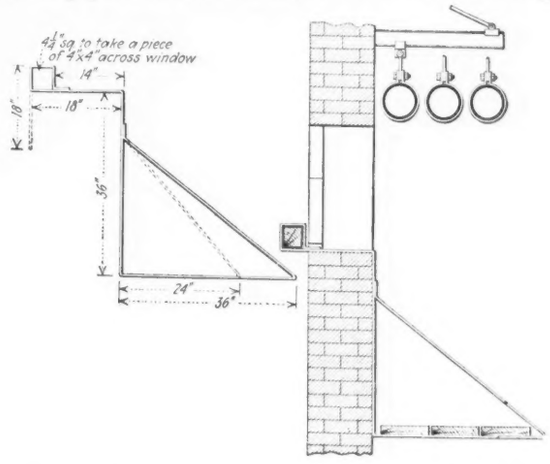
In doing the job this way it was figured that about 300 man-hours of labor were saved, besides the cost of the additional material that would have been required to rewind one-half of the machine completely.

The machine has been in service for two years with entire satisfaction since the repair was made, each lamination being held to the core by two dovetails securely anchored the renewed section to the frame. Futhermore, the new section is anchored into the core like the keystone in an arch. The two joints between the replaced sections and the original core, if properly made, will have but little effect on the magnetic characteristics of the machine. They should be as good magnetically as the joints between the halves of the core.

Wisconsin Rapids, Wis. E. E. BELTER.

## Improvised Hanger to Support Staging While Erecting Pipe Lines

WE RECENTLY ran several pipe lines along the sides of our building. The length of the run was too great to build a staging to put up the hangers and erect the pipes and cover them, so we devised the hangers




*Staging hangers were suspended from windows*

illustrated. These were made to be suspended from the bottoms of the windows and permit the windows to be nearly closed when they were in place.

The original hanger was made to hook over the wall under the window, as shown by the dotted line in the detail. Numerous obstructions, however, such as piping, benches, etc., made it difficult to use the hangers, so they were changed, as shown by the solid lines. The improved model has a loop through which a piece of 4x4-in. timber is placed. The hanger was also made wider.

Watertown, Mass. THOMAS A. WALSH.

## Power-Plant Preparedness

A POTENTIAL duty of every power-plant attendant is mental preparedness for taking care of any condition that might possibly arise. In order that emergency repairs may be carried out effectively and that shutdown of plant or equipment may be reduced to the minimum, it is imperative that all tools and stock supplies should be kept in specified locations and that everyone about the power house should know exactly where to go to obtain them without the least delay. Impromptu repairs are often necessary, and a good engineer or fireman, who takes a personal iinterest in his work, will have mentally repaired any possible fault that may develop in the system under his care. The responsibilities of engine room attendants are second to none, and it is fitting that they should continually practice a policy of preparedness.

Toronto, Ont., Canada. JIM HENDERSON.

# *As the Other Fellow Sees It*

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

## *Some Advice on Welding*

I WAS much interested in the letter by E. O. Leseid in the Oct. 2 issue narrating his experience with local welders and the repairing of cracked cylinder heads, as I have had considerable experience the last few years in work of this kind.

At the outset it may be mentioned that the statement, "I advise you to look well into the welding man's record, for not every mechanic can make a satisfactory weld," in the first paragraph of the letter referred to agrees exactly with my own observations.

It should be emphasized that proper welding apparatus, skill and training are essential to weld properly and to make joints sound throughout, together with knowledge how to apply the system as well as how to design and prepare the work for being welded.

Owing to the almost entire lack of elastic properties in cast iron, the effects of expansion and contraction during and after welding must be considered. It is necessary, therefore, to preheat fractured and cracked cast-iron machinery parts when welding with the oxy-acetylene torch, and using filler rods of the same material if the best results are to be secured. Preheating relieves residual strains and compensates for expansion and contraction; it prevents gas pockets and blowholes by holding the metal in a plastic or fluid state sufficiently long after deposit to enable the gas to escape and the foreign matter to be released and floated on the surface; it aids in securing good cohesion and reduces to a minimum the formation of the layer of slag; and it prevents chilling of the deposited metal and assists in the desirable slow cooling process. Experience and observation have demonstrated to me that many correctly welded castings break during cooling, simply because proper precautions have not been taken to avoid rapid cooling. This cooling may be retarded by the use of asbestos sheets, heated ashes or heated slaked lime. Dry sawdust may also be used with good results, particularly on small castings.

The commonest form of preheating is by a charcoal furnace fire. This method produces an even constant heat and does not require expensive equipment to apply it. A suitable furnace can easily be built with firebricks to the shape of the casting—with the necessary room allowed for turning the part while hot. The charcoal will burn steadily and with attention will bring the casting up to the desired heat for welding; also, after the welding operation has been completed, the fire can be replenished, the cylinder reheated evenly and allowed to cool down slowly, which is so essential to insure a satisfactory cylinder-head repair job.

As the modern method of repairing fractured and defective cast-iron parts with the oxyacetylene torch and bronze is not so well known among welding operators and power-plant mechanics as it ought to be, a brief review of how broken and fractured cast-iron parts can be successfully repaired without extensive preheating might not be amiss. Of course, the application of bronze is not welding in the strict sense of the term, as it is more a process of brazing, but by its use a bond can often be effected on cast-iron that will be stronger than the parent metal.

The advantages of this brazing or bronze-welding process are: Its rapidity; the small amount of preheating necessary; increased ductility; less contraction stresses; greater strength and rigidity. The temperature at which bronze welding is conducted is about 700 deg. C. (1,300 F.). If a casting is not heated to the proper temperature, the bronze will not adhere, and if it is raised to too high a temperature, the bronze will run off.

The weld areas should first be well "tinned" with the bronze, and after the tinning coat has been applied, bronze weld metal can be added fairly rapidly, using a specially prepared flux as necessary, until the weld of the proper height has been built up. It is desirable that all bronze-welded joints should be well reinforced.

Welding should start at least one-half inch beyond the visible ends of the crack in a casting. If the crack is long, it may be desirable to tack-weld it in one or two places or to begin welding in the center and weld both ways. It is important that overheating of the cylinder head or the bronze welding metal should be avoided. Experience has shown that in many cases the actual cost of making the repair by brazing or welding is not the most important feature. Generally, it is the time element that counts in power-plant installations and industrial establishments, especially where the replacement of a machine part would entail a long delay or shutdown.

Manchester, Eng. E. ANDREWS.

* * * *

## *How Clinkering Is Eliminated in Pulverized Coal Furnaces*

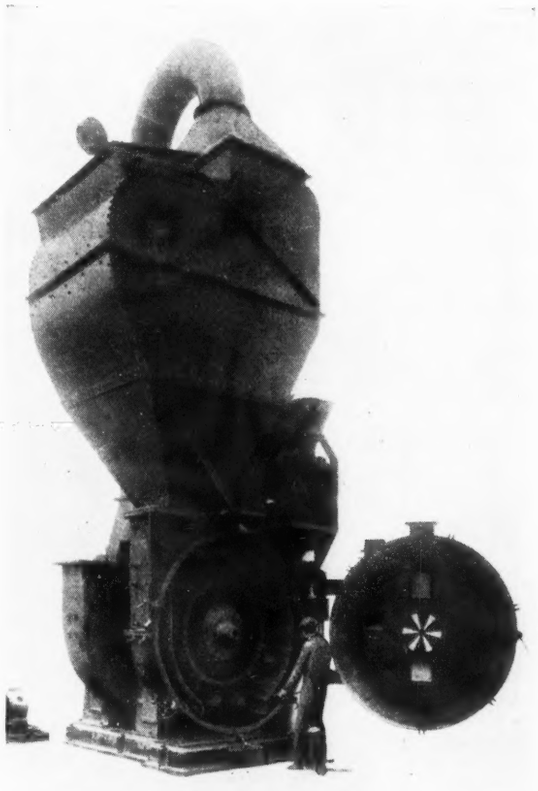
THE Cahokia station of the Union Electric Light & Power Company, St. Louis, Mo., was the second station in this country designed for pulverized coal, and in three sections built consecutively over a period of six years has shown major developments leading to greater dollar economy, the most recent being the elimination of furnace clinkers which is a trouble due to combustion and occurs in its most severe form where unburned and partly burned fuel is carried by hot gases and brought in contact with ashes and some air.

This trouble should not be confounded with that of the ash slagging, a problem that has been readily overcome at Cahokia station by the proportionating of the amount of direct boiler and furnace water-wall surface exposed to the radiant heat of the fire in relation to the quantity of coal burned.

Apparently, clinkers are formed by mechanical adhesion of the particles of ash while at red heat or by fusion of the ashes in contact with burning carbon due to improper preparation and transportation of the fuel before it is completely burned. The chemical composition of the ashes, the general furnace temperature and the amount of water-cooling surface have had little influence on the formation of clinkers, as when an incandescent piece of carbon rests on or is thrown against particles of ash,

they adhere or fuse together, forming clinkers. This clinkering was eliminated only when the coal was reduced to such a fineness that it would burn while in suspension and in a segregated state.

The major problem at Cahokia was to reduce the fixed and operating charges for the fuel-burning equipment and to better operating conditions. This has been accomplished with the unit system as installed in the latest extension of the station. With this system it is possible to maintain the fineness of coal at each boiler furnace at between 85 and 60 per cent through 200-mesh screen, the higher percentage being obtained when the mill wearing parts are new and the lower when they are old.



*A 23,000 lb. per hour capacity pulverizer on which the pulverizing element is readily accessible*

The short-flame mixing-type burner[1] adopted, burns the fuel while in suspension almost instantaneously in a segregated state, preventing unburned fuel from striking the walls or falling to the bottom. This has a marked effect on the flame characteristics in the furnace, eliminating furnace clinkers and assuring the continuity of service at high boiler ratings over long periods. The change to this type of burner, from those used in the older section of the station, has prevented the formation of clinkers at the bottom of the combustion chamber which caused on outage of about 25 per cent.

The Cahokia station ranks as a pioneer utility plant to adopt pulverized fuel, and higher capacity has maintained its position pioneering the installation of unit-system pulverized-fuel firing with mixing-type burners, being the first large station to select that method of firing, which has proved to be an important step toward producing steam at lower costs.

The unit mills used[1] are 15,000 lb. capacity each, impact-type pulverizers (two per boiler unit), the largest in this country. They cannot as yet be considered as the limit for capacity. The accompanying illustration shows a 23,000-lb. unit pulverizer in operation in France. This mill is of an improved type to maintain fineness of product and offers great facilities for quick repairs. This would indicate that this type of apparatus in this country, although comparatively new, has not reached its limitations, which, together with mixing-type burners, should be designed to prevent any coarse particles of fuel that cannot be burned instantaneously in the segregated state from entering the furnace in order to prevent furnace clinkers.

J. GOULD COUTANT.

New York City.

[1]See article by E. H. Tenny, Jan. 31, 1928 issue.

* * * *

## On the Use of Water Softeners

I HAVE been much interested in the articles by E. O. Leseid appearing in *Power* under the heading "Letters from an Oil Engine Operator," and particularly so in the one in the Nov. 6 issue entitled "On the Use of Water Softeners."

As the company with which I am connected is interested in the promotion of the sale of water purifying and softening equipment, we are appreciative of Mr. Leseid's brief for the softening of the cooling water used in oil engines.

We feel constrained, however, to take exception to his recommendations, as it has been our experience that the order of the desirability of the two types of softeners mentioned is just the reverse of the order in which Mr. Leseid presents them. In other words, when the makeup water to a cooling system is to be softened, it has been our experience that the most desirable results are obtained when the makeup is softened in a zeolite softener. Of course, softening with lime, soda ash and sodium aluminate is to be preferred to no treatment at all, but this method falls short of providing the maximum possible benefits because even under the most favorable conditions completely softened water cannot be obtained by this method.

With a zeolite softener, on the other hand, as long as the softener is regenerated at the proper intervals, the water passed through it will be uniformly and completely softened. Inasmuch as the zeolite softener replaces the calcium and magnesium compounds with the corresponding sodium compounds, the water contains only soluble salts, which may be concentrated to comparatively great concentrations without difficulty from precipitation.

With the chemically treated water about the best that can be expected under average operating conditions is a hardness of from 1½ to 3 grains per gallon in the treated water, and on concentration in the cooling system this hardness will double and treble in a short time, so that the cooling system will again be filled with relatively hard water. Furthermore, the chemically treated water will have a caustic alkalinity due to calcium hydrate, and on bringing this water into contact with the air during the cooling process, carbon dioxide is absorbed and calcium carbonate formed, thus further increasing the hardness of the treated water.

Inasmuch as we are manufacturers of both the chemical type and zeolite type of softeners, the foregoing comments are not a condemnation of the lime and soda ash softener as such, but are made with the idea of pointing out the use for which the zeolite softener is best adapted.

Chicago, Ill A. C. EMBSHOFF, Technical Staff,
International Nickel Company.

# What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

## Nygaard Furnace Water Wall Has Unique Features

EMPLOYMENT of a unique locking arrangement on the refractory blocks, which permits renewal from the fire side, elimination of metal clamps and large contact area between the blocks and tubes, are some of the important advantages claimed for the Nygaard water wall, recently introduced by the Bernitz Appliance Company, 80 Federal St., Boston, Mass. Fig. 2 is a detail of the block in position on the tube and Figs. 1 and 3 front and rear views of the wall assembly.

From a study of the illustrations it will be seen that the blocks are made to fit the tubes on the sides rather than on the face next to fire, as is the usual practice. The blocks also have tapered projections which interlock one with the other. By virtue of this design the blocks clamp themselves on

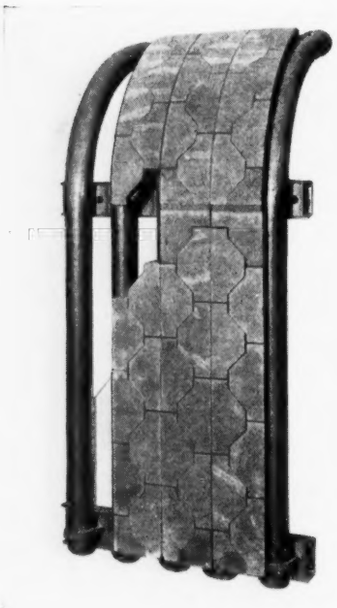


*Fig. 1—Furnace side of wall assembly*

the tubes without the use of auxiliary metal clamps, and the tapered surfaces tend to force the blocks outward against the tubes and to give an intimate contact with the tubes when assembled. The blocks, in addition to fitting half-way around the tubes, are interlocked on the vertical plane by means of a small projection on the tapered surfaces. This feature makes them adaptable for use on arches and on bent-tube construction.

Probably the most important feature of the wall is the flexibility; not only are clearances provided between the blocks horizontally and vertically, but every block can be renewed from the fire side without removing the insulation or outer covering.

The tubes are rigidly spaced by means of 4-in. channels which

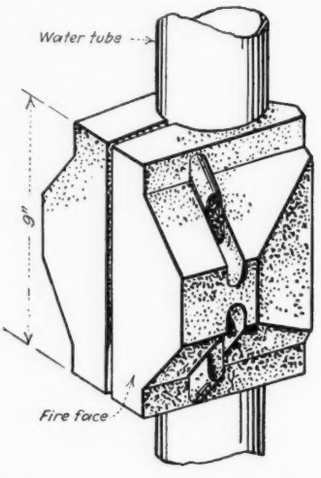



*Fig. 2—Detail of block in position on tube*

straddle several tubes. The channels are spaced three to four feet apart and have cast-iron blocks which fit the curvature of the tubes and protect the channel from the heat. U-bolts clamp the channels to the tubes and, in addition, serve to support the blocks sectionally, thus facilitating the renewal or replacement of them.

As will be seen from Fig. 1, each section is finished off with a half block topped with a key brick having a downwardly extending lug in the rear to fit the triangular space between the blocks. When the key brick is in position, the remaining space, approximately $\frac{3}{8}$ in., is filled with refractory cement or other suitable material. To renew the blocks, the cement and key bricks are removed, and this releases all the blocks in that particular section, as no cement is used between them. The

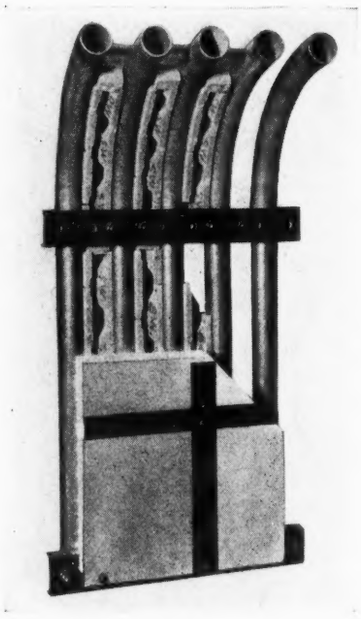


*Fig. 3—Rear view of wall*

blocks are made of the silicon carbide refractory "Carbofrax."

The wall is being put out with two tube sizes and spacings, one being $3\frac{1}{4}$-in. tubes on 6-in. centers and the other 4-in. tubes on 7-in. centers.

## Type Ao Valve Operating Unit for Valves up to Six Inches

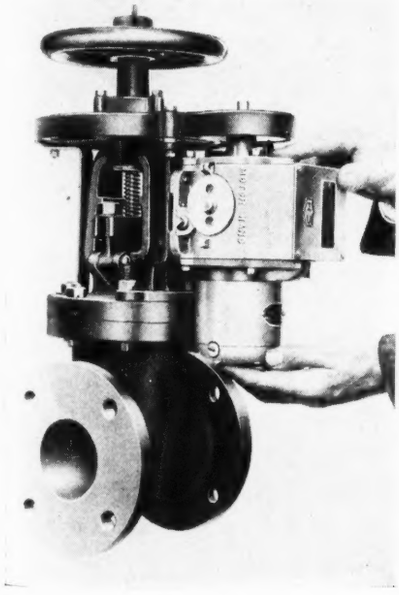
THE type Ao valve-operating unit illustrated, designed primarily for valve-operating services in industries where regulation of pressures and temperatures, of gases and fluids, is necessary, has been introduced by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., to supplement its regular line of "Dean" valve-operating units.

The Ao unit has been designed especially for valves from one to six inches, and is similar in principle to the larger units manufactured by this company. It is self-contained, with the speed reduction between the

motor and the valve spindle made by means of hardened-steel spur gears, totally inclosed and by a single spur-gear drive on the valve stem. A disengaging mechanism is provided for hand operation, and the hub of the stem-nut driving gear is extended to carry a handwheel as shown.

Reversing relays are built in and are mounted in a compartment of the gear reduction case. These relays are mechanically interlocked to allow the unit to operate in any position. A limit switch of the traveling unit type is also incorporated and is adjustable up to 120 turns of the slow-speed shaft. The slow-speed shaft is driven through torque springs, which provide positive drive and at the same time give a cushioning effect to protect the seat.

The unit is arranged for conduit wiring and is complete, requiring only a push button, thermostat, float switch or similar automatic device for starting or stopping the motor. Push-button stations are available, which, in addition to the functions "open," "stop" and "close," are equipped with a red and green lamp, indicating when the valve is closed or open. Both lamps are lighted when the valve is in an intermediate position. These stations can be mounted single, in convenient locations, or grouped on a panel to centralize the control.



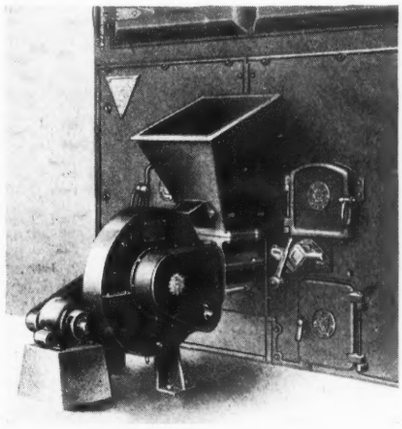
*Motor-driven valve operating unit*

A special high-speed high-torque motor of 110 volts, for alternating or direct current is used for the driving unit and is entirely waterproofed for outdoor service.

## Riflex Mechanical Drive for Jones Stokers

A NEW mechanical drive for the Jones underfeed stoker, known as the "Riflex," designed to give a variable coal feed with a constant-speed motor as well as to obtain a quick thrust of the plunger so as to give an effective slicing action to the fuel bed, has been brought out by the Riley Stoker Corporation, Worcester, Mass.

The drive consists essentially of a large spur gear which rotates continuously and which operates the crankshaft and plunger intermittently by means of a clutch keyed to the crankshaft, the number of the strokes of the plunger per minute or per hour being regulated by a specially designed timing mechanism inclosed within the gear case, but having an indicator and dial on the outside, showing the various speeds, 24 in all.



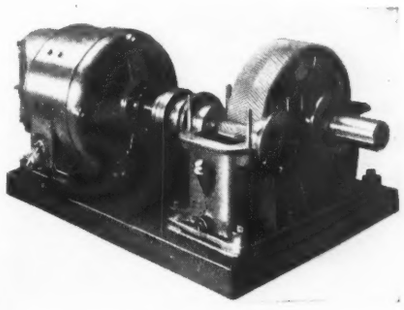
*Mechanical drive with twenty-four speed adjustments*

The large spur gear, previously referred to, is driven by a constant-speed motor through a chain and back gear, and the timing mechanism functions to regulate the speed of the coal feed, giving a range of capacity between 60 and 6,000 lb. of coal per hour. This flexibility or wide range of feeds permits a fire to be banked quickly or to be brought up quickly. At maximum speed a complete stroke of the plunger is made in less than four seconds, and at the slowest speed a stroke is made every twelve or fifteen minutes. Spur gears only have been used for the speed reduction, and the design of the timing adjustment is such as to make it adaptable to automatic regulation by means of a regulator operating from the steam pressure.

## Farrel-Sykes Roller Bearing Speed Reducers

THE single-reduction speed reducer illustrated is one of a number of types comprising a new line now available in capacities from one to 5,000 horsepower.

The reducers have Sykes generated continuous herringbone teeth and roller bearings which combine radial and thrust capacities on both shafts. Both pinion and gear shafts are held from end float. The illustration shows a single reduction unit mounted on the same baseplate with the motor. This type is available for ratios between 2 to 1 and 10 to 1 in ratings from 3 to 300 hp. Several types of double reduction units are also available in ratios between 10 to 1 and 60 to 1, and ratings from five to 200 horsepower.



*Single-speed reduction unit mounted on base with motor*

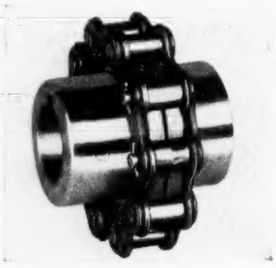
Rolling-mill reduction units are designed to suit each individual condition. They are available in ratios between 1 to 1 and 5 to 1, and in sizes up to 5,000 hp. These units are fitted with bearings of the plain roller type or other type, as best suits the service on which the unit is to be used. The bearings are held in cast-steel sleeves which are adjustable. The units are manufactured by the Farrel-Birmingham Company, 344 Vulcan St., Buffalo, N. Y.

## Sprocket Chain Type Flexible Coupling

THE Clark flexible coupling, formerly made by the I. H. Dexter Company, Goshen, N. Y., has been acquired by the Diamond Chain & Manufacturing Company, Indianapolis, Ind. The standard type, shown in the illustration, is generally used for constant-torque drives. It may be obtained with either cast-iron or steel sprockets, and is available

in bores from $\frac{5}{8}$ to $8\frac{5}{8}$ in. in steel and $1\frac{1}{4}$ to $7\frac{1}{2}$ in. in cast iron. The driving member is a flexible chain wrapped around the sprockets as shown.

Type "E" coupling is designed for heavier strains than the standard type. The sprockets are of steel and the

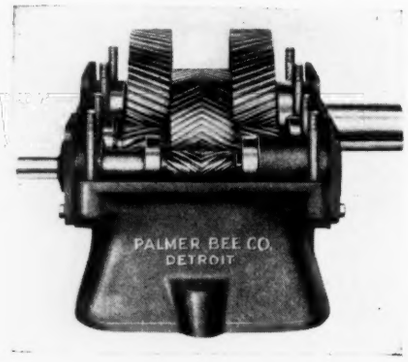


*Clark Flexible Coupling*

hubs are of cast iron. The large sprocket type is suitable for pulsating drives.

## Single, Double and Triple Herringbone Speed Reducers

IN THE double speed reducer illustrated, the gears have been so arranged as to form an unusually compact unit. The high-speed gears are continuous herringbone type (Sykes generated), and the slow speed herringbone gears are divided in the center. This is done to give a more symmetrical arrangement of the gearing and a more equal distribution of the load on each bearing.




*Double-speed reduction unit*

The shafts are of alloy steel and both high- and low-speed shafts are made large enough to take care of overhung loads up to the maximum capacity of the reducer. The pinions are cut integral with the shaft, and the teeth are generated on the large gears after they are fitted onto their respective shafts. Ball bearings are used on the high-speed shaft and roller bearings on the intermediate and slow-speed shafts. The housing is of cast iron and is designed for the three-point method of mounting in place of the four-point as generally used.

The reducers are designed to permit the use of a heavy body lubricant. The gears and bearings are lubricated by splash from the large gears. This new line, which is being put out by the Palmer-Bee Company, Detroit, Mich., includes also single reduction units in which both shafts are mounted on tapered roller bearings.

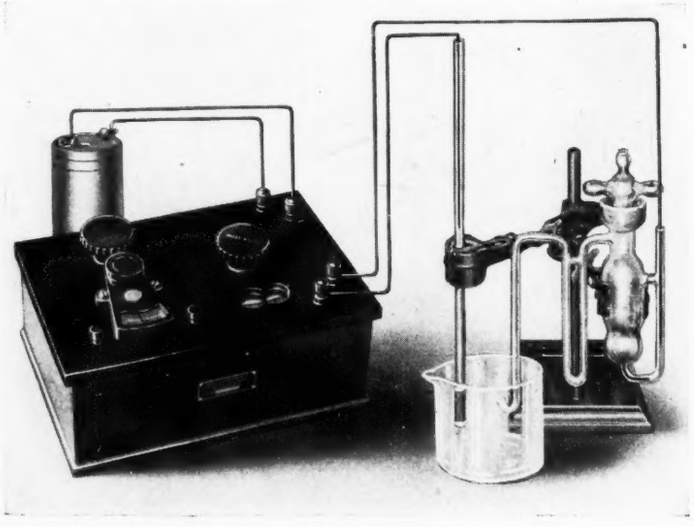
## Electrical Indicator for Hydrogen Ion Determinations

WITH a view to facilitating and simplifying the making of hydrogen ion determinations, the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., has brought out the electric pH indicator illustrated.

The equipment, which is designed for process control in tanneries, textile and other industries, consists of a potentiometer, calomel-electrode vessel and quinhydrone electrode.

It is pointed out that the instrument is specifically designed for the quinhydrone electrode, and when using it the electrode connections never have to be reversed. The range of the instrument is 1 to 9 pH, and practically all common solutions whose pH value is in this range can be measured.

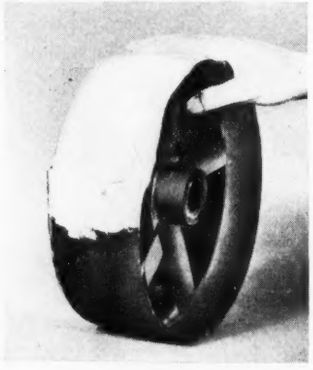
In using the instrument there are no colors to match. It measures electrically by what is known as the "Null" potentiometer method, and readings are guaranteed correct to 0.1 per cent pH.



*Electrical equipment for hydrogen ion determinations*

## Pulleystone Anti-Slip Pulley-Facing Compound

FOR reducing belt slippage an anti-slip compound known as pulleystone has been announced by the Chicago Belting Company, Chicago.



*How pulleystone is applied to pulley face*

It is a plastic material and is applied to the pulley face in a thin coat, as shown in the illustration, by spreading it over the surface with the hand and then smoothing it out with the back of the hand dipped in warm water. The surface thus produced, it is claimed, gives high adhesion, which increases with service. It can be used with practically all types of pulleys and belting.

# Automatic Combustion Control
## *in Industrial Plants*

*Abstract of paper by B. A. Weimer, Carrick Engineering Company, presented at the Wisconsin N.A.P.E. convention, July 18, 1928.*

THE present tendency in power-plant design and operation is toward greatly increased ratings and greater economy. This is a natural development, as the costs of both raw materials and labor have increased to a point where the maximum production at maximum efficiency must be secured from any piece of equipment. Forcing boilers at these high ratings necessitates a degree of vigilance in watching operation that cannot be had in the industrial plant, which is usually undermanned. The rule, consequently, is for the firemen to supply steam regardless of how much this steam is costing, or to use "rule of thumb" in proportioning fuel and air to the load.

At some time during the life of the steam-generating equipment, boiler tests are run, either for their acceptance or as a result of an efficiency campaign. Subsequently, it is the continual cry of the management that it cannot understand why the economy secured on test cannot be maintained in every-day operation. The answer is obvious, since during the test run there were more men and a better class of men operating the boiler plant. It is easy to maintain uniformly high efficiency over a short period of time—a day or less—if constant watch is kept over all variables. When the operating personnel is cut down to the absolute minimum, it is hardly fair to assume they can achieve the same results as were secured during "test" conditions.

Still, every fireman has thousands of coal dollars placed in his hands every day for him to spend, and there must be some way of assuring a maximum return for these coal dollars. The answer lies in automatic combustion control of proper design, properly fitted to the power plant's technical and economic needs. Automatic combustion control, once properly set, maintains test efficiency in every-day operation, and also increases economy in other directions, as will be discussed later.

### Methods of Combustion Control

There are three common methods of boiler plant control—manual control, the so-called "base-load method" and full automatic or machine method of control. Under hand control the operator endeavors to increase the rate of fuel and air supply with the increase of load, but is handicapped owing to several factors. First of all, no matter how vigilant or intelligent he may be, he depends upon his observation of the instruments in the boiler room for diagnosing conditions. When one considers that a steam gage may be inaccurate as much as two pounds and that flow-meter indications are not sufficient to base the entire control, we can see just how handicapped the man is. In additions he cannot tell just how much of a change is necessitated and must wait for the effect of his change in firing rate to manifiest itself on his instruments before he can make another correction. In other words, it is a cut-and-try process, resulting in low combustion efficiency, high furnace maintenance costs (due to alternate heating and cooling of the brickwork) and usually the possibility in the background of decreased production efficiency in the factory due to the non-uniformity of steam supply.

With the base-load method of control a certain proportion of the boiler plant is operated at the most efficient rating, and the rest of the boilers allowed to "swing" to take care of peaks in the load. The objection to this mode of control lies in the fact that it is more economical to vary the rating of many boilers through narrow limits close to their best point than it is to allow a few boilers to swing over a wide range.

### Machine Regulation Eliminates Personal Equation

With machine regulation we are not limited by the personal equation, since all the corrections are made by machine, which, with properly designed regulators, means that all the changes in combustion rate will be exactly proportional to the change in demand. Automatic combustion control is universal in its application; it can be advantageously applied to any fuel or firing system. The application of the proper type of control system enables the firemen to act as load dispatchers rather than as coal-passers. It fulfills the same function as a governor on a prime mover, and is really more essential than a governor, owing to the fact that as many as five variable functions must be correlated in order to secure satisfactory results.

The use of the right type of combustion control results also in a considerable increase in boiler economy, a decrease in furnace maintenance, in some cases lower labor costs, and an increased generating capacity of the boiler plant itself. Automatic control makes possible an increase of effective generating capacity in two ways; first, the boiler may be regarded as a large prime mover which is equipped with a flywheel in the form of a fuel bed. By utilizing the inertia of a flywheel, we are enabled to carry momentary loads considerably in excess of the torque developed by the prime mover; in the same way the presence of the fuel bed and of the hot water in the boiler enables sudden peak loads to be carried provided a "flying start" is had by increasing the air supply before the load increment comes on in its full amount. Second, application of control decreases the excess air and permits greater utilization of the capacities of the chimney, breeching and boiler due to the smaller volume of gas that must be handled.

Automatic control has been censured, due largely to the fact that the first machine developed did not accurately proportion the combustion rate to the demand; at the present time, however, there are several machines on the market that will function continuously, positively and accurately, to maintain the proper relation among all the variables entering into the generation of steam.

The application of an automatic control system will vary with individual plant needs, but these plants can be divided, for the purpose of discussion, into those utilizing natural draft (including induced draft) and those using forced draft.

### Application to Plant Using Natural Draft

In the natural-draft plant, the number of variables that can be controlled is limited, there being no accurate means of proportioning fuel and air. The commonly accepted system used employs a steam-pressure measuring device which adjusts the rate of fuel supply and the position of the boiler outlet damper in accordance with steam-pressure variations. By this means a proportionality between fuel supply and steam demand is secured, and, so long as the fuel-bed resistance remains reasonably constant, substantially uniform economy is maintained. This system of control is the simplest that can be satisfactorily employed as a combustion-governing means.

The trouble with this system, from the viewpoint of theoretical considerations, lies in the inaccuracy with which fuel and air are proportioned. If we were to insert, between the master steam-pressure regulator and the outlet damper, some form of measuring device that would maintain a fixed volume of air passing through the boiler passes for each master control position, accomplishing this by outlet damper adjustment, the problem would be solved, for there would now be strict proportionality among air, fuel, and steam output over the entire boiler rating range. This is what is actually done with pulverized-fuel installations, and in the larger

stoker-fired plants; by maintaining a differential across the boiler passes proportional to header steam pressure variations, the desired air volume measurement is secured.

### Application to Plant Using Forced Draft

In forced-draft plants the simplest installation consists of a master steam-pressure-actuated regulator, which adjusts the fuel supply and the breeching damper position with load changes. At the same time a constant pressure is maintained in the combustion chamber of each boiler by manipulation of the blast damper. By this means, we have strict proportionality between fuel supply and steam demand, and a substantially constant air-fuel ratio, since the adustment of the blast damper constitutes a correcting factor for fuel beds of varying characteristics.

To improve on this system we may add a volume-measuring device, as before, to adjust the breeching damper; this merely eliminates the guesswork incident to the relation between damper position and gas delivery through the orifice so formed. It should be kept in mind that there is no accurate method of "integrating" the damper position and dispensing with the volume-measuring machine. Even though it is possible, by the use of a properly shaped cam, to make damper orifice area proportional to the movement of the regulating device, yet there are still the inaccuracies due to increased velocity through extremely narrow openings, and the effect of a warped damper or of varying stack draft, induced-draft fan speeds, etc. The use of a measuring, or "results" type of regulator, as distinct from a machine of the "proportioning" type, like the steam pressure control, prevents the alteration of any of these factors from affecting the accuracy of regulation—certainly a well-merited improvement.

### Fan Control a Secondary Factor

With all these applications the question of fan control has purposely been omitted, since this is at best a secondary factor, and because the method of control application will vary with the plant layout. For example, the forced-draft fan speed may be controlled by the steam pressure, by the position of the blast damper, maintaining the latter within a certain operating range, or to maintain a constant pressure in the blast duct.

In the pulverized-fuel fired plant the method of firing presents the utmost in flexibility. This should be utilized to the fullest possible extent by the intelligent application of control, since slight inaccuracies will completely disrupt the operating ratios with this type of firing. In general, the application of combustion-control machines to it will closely parallel the application to stoker-fired plants, save that the fuel bed no longer exists to complicate matters. The questions of flame travel and primary and secondary air distribution, however, must be considered.

It is only when machines conceived along fundamentally sound lines, properly designed, built and erected under the supervision of trained combustion engineers are used in control applications that the optimum results can be obtained. Then only will we have achieved our goal—to substitute the *science* of accurately measured changes in combustion rate for the "art" of firing.

# Recent Publications

Standards of the Hydraulic Society. Published by the Society, 90 West St., New York City. Paper; 9x11 in.; 78 pages. Price, 50 cents.

THIS edition of the Standards of the Hydraulic Society contains in addition to definitions, extracts from A.S.M.E. test codes, recommendations of the Hydraulic Society as to what is considered good practice in the pump industry, and a considerable amount of data, tables and curves of use to the hydraulic engineer.

1928 Supplement to Book of A.S.T.M. Standards. Published by American Society for Testing Materials, Philadelphia, 1928. Paper; 6x9 in.; 195 pages. Price, $1.50.

This supplement contains new or revised standards adopted since the publication of the last edition of the A.S.T.M. Yearbook. Those of interest to power engineers are: A 18-28, Carbon Steel and Alloy-Steel Forgings; A 105-28, Forged or Rolled Steel Pipe Flanges for High Temperature Service; B 61-28, Steam or Valve Bronze Sand Castings; C 64-28, Clay Firebrick for Stationary Boiler Service; C 24-28, Test for Softening Point of Fireclay Brick; C 27-28, Clay Refractories (Terminology); C 71-28, Terms Relating to Refractories.

Anthracite Culm and Silt. By James D. Sisler, Thomas Fraser, and Dever C. Ashmead. Topographic and geologic survey bulletin M12, published by Department of Internal Affairs, Commonwealth of Pennsylvania. Paper; 6x9 in., 268 pages.

THIS bulletin is the result of a cooperated study by the Pennsylvania Topographic and Geologic Survey, the Pennsylvania Water & Power Resources Board and the United States Bureau of Mines. This study has had as its basis two general problems. The first phase answers the question, Where are the silt and culm deposits to be found? How much of this material is available? What is its quality? How can it be used? The second phase of the investigation concerns stream polution and channel silting.

The silt and culm deposits in the anthracite region have been increasing in value each year. The product, which has been more than a waste—a nuisance, is now of value and will increase in value as the price of anthracite increases. It has been estimated in the survey that the total annual production of silt approximates 8,900,000 tons a year and that the quantity of culm and silt stored in the anthracite region is in the neighborhood of 200,000,000 tons.

Plumbing Questions and Answers. By Joseph E. Taggart. Third edition. Published by the Scientific Book Corp., 16 East 26th St., New York City. Cloth; 5x7 in. 164 pp. Price, $2.00.

THIS book is based on the plumbing code of the City of New York. There are 190 rules in the code and each of these has been converted into a question and answer, some with sketches to make them clearer. The questions and answers cover the filing of drawings and descriptions of jobs to be done, definition of terms, materials to be used and quality of workmanship, drains, sewer connections, traps, waste pipes, water supplies for fixtures, and testing the plumbing before it is covered. An appendix is included that contains a number of useful tables, measures and calculations.

The book meets the requirements of a reference for plumbers, and a textbook in colleges, trade schools and institutions where plumbing is taught.

Compressed Air Trade Standards. Third Edition. Issued by The Compressed Air Society, New York City. Paper, 8½x11 in.; 48 pages. Price, 50 cents.

THIS edition of the trade standards adopted by the Compressed Air Society contains definitions of the various technical terms used in the industry. That a few are neither clear nor logical is due to the variation in the views of the compressor builders. Those who manufacture blowers do not attempt to obtain anything like isothermal compression, and consequently the blower efficiency is low if isothermal compressor be used as the basis. There is, however, no logic in stating efficiency in terms of anything but isothermal compression, for the user seldom gets the air to the consuming tool at a temperature above that of the atmosphere. The buyer and user of compressed-air machinery will find much value in this booklet.

Mineral Resources of the United States in 1927, by F. J. Katz and M. B. Clark of the Bureau of Mines, is a statistical compilation of the quantity and value of mineral products of the United States.

# *Low-Temperature Distillation of Lignite*

*These excerpts from a paper read by Max Toltz, before the summer meeting of the American Society of Mechanical Engineers, St. Paul, Minn., Aug. 27 to 30, 1928, will be suggestive to those located in a district producing lignite.*

DEPOSITS of some 9 billion tons of lignite occur in North Dakota, South Dakota and Montana. These are little used except for domestic fuel at the rate of about 2½ million tons a year. During the last 30 years experiments in the briquetting of this lignite have not met with success, chiefly because of the necessity of transporting the binding material over long distances to the fields.

Lignites found in the foregoing states differ considerably in quality, as is evident fro mthe analyses tabulated below.

On account of the high water content this lignite cannot be shipped long distances. It has another disadvantage in that it slacks readily when stored and crumbles into powder. Therefore, low-temperature distillation seems to be the only method whereby this fuel may be utilized advantageously and conveyed to the people of the Northwest within a radius of about 600 miles of its source.

Low-temperature distillation may be defined as consisting of a heat treatment not exceeding 1,000 deg. F., whereby the decomposition of the tar is prevented, thereby releasing the maximum amount of liquid byproducts and at the same time producing a smokeless fuel, called semi-coke, or char. The yield of tar, of course, is eliminated when the use of a gas of high thermal value is preferred. It should be mentioned that tar water constitutes another byproduct. The reason why low- instead of high-temperature distillation is preferable, may be found principally in the larger yield of liquid fuels.

TYPICAL LIGNITES OF THE NORTHWEST

| Site | Moisture | Ash | Volatile | Fixed Carbon | B.t.u. as Received | B.t.u. Dry |
|---|---|---|---|---|---|---|
| Rosebud (Montana) | 23.65 | 9.51 | 30.00 | 36.86 | 8,750 | 11,450 |
| North Dakota | 36.18 | 8.70 | 29.17 | 25.35 | 6,700 | ..... |
| North Dakota | 32.64 | 11.42 | 29.10 | 26.25 | 6,970 | ..... |
| North Dakota | 43.87 | 5.82 | 24.88 | 25.43 | 5,938 | ..... |

### Char Is Valuable Fuel in the Northwest

In the Northwest there is need for a commercial fuel for domestic and industrial purposes. The char, which is a product of the low-temperature distillation process, consists of distinct small granules or particles ranging in size from one-sixteenth to nearly three-fourths inch. Special grates are required to burn char of this kind under boilers. In Europe the char is used on chain grates, but the tendency is toward the employment of this fuel in powdered form.

Conditions prevailing in the territory under discussion require the briquetting of the char, which is easily accomplished by the addition of about 6 per cent of byproduct tar as a binder. It is noteworthy that in one plant in middle Germany experiments have been conducted during the last two years for the purpose of evolving a method of making char briquets without a binder.

In this discovery lies the solution of the Northwest fuel problem. When its use is available here, the problem of handling the lignite in the form of briquets as a domestic, industrial and railroad fuel will have been solved. Economical transportation throughout the tributary territory will then be possible, and char briquets can compete with coke or any Eastern, Illinois or other bituminous coal now sold in the territory.

The average yield of tar from lignite is about 9 per cent of the total weight, its value for chemical purposes increasing in proportion to the freedom from dust and other substances. In Europe light oils, such as benzol, and heavy oils for lubrication are extracted from this tar, but the most valuable product is paraffin, as its consumption is increasing every year and it has an extensive field of application in the manufacture of electrical appliances and accessories. This tar contains too small an amount of asphaltum to warrant extraction. From the tar water ammonia sulphates are distilled as byproducts, which are used in the manufacture of fertilizers, smokeless powder and ice. The use of ammonia sulphates in the manufacture of fertilizers is of great importance, even though at present, in this country, the market is swamped with this material. Acetate of lime, in the form of brown or gray lime, used in the distillation of acid salts and pure vinegar, is another byproduct of tar water.

The writer is of the opinion that the fuel economy of a power plant will be raised by using low-temperature distillation of coal and producing gas of a high B.t.u. content whenever such power plant can be connected with a gas works. The char should be used in pulverized form under the boilers. Where superheated steam instead of gas from producers is used for the distillation of the coal, a great benefit can be derived by using the dry-quenching process, as the heat of the char may be utilized under a separate boiler for raising low-pressure steam or for superheating the steam that is used in the process of distillation.

### Type of Retort Giving Best Results

For the low-temperature distillation of lignites externally heated retorts seem to be the most advantageous, as this method yields the highest quantity of char, containing from 10 to 15 per cent volatiles, and produces the greatest amount of tar. Compared with the systems using internally heated retorts, or the high-temperature distillation of fuels, the yield of high thermal gas will be low.

Drawing conclusions from the results achieved in Europe, particularly in Germany, we may infer that the success of low-temperature distillation lies along the line of briquetting the char, thus facilitating its handling and shipping to the tributary country lying within the radius of low cost of transportation, within which it is possible to meet competition from other fuels. It is certain that housewives will approve the use of this fuel for cooking and heating purposes. For industrial purposes the briquets may be used, and if the distance from the carbonizing plant is not too great, the char could be shipped and, after pulverization, used as fuel at the boiler plant. Even the railroads may use the briquets with excellent results and with the assurance of obtaining smokeless combustion, a feature that is highly desirable.

### Importance of Gases

If the high thermal gases can be used, the whole process will be simplified. But if it is impossible to use them directly, they should be condensed and the tar and tar water separated. If clean and practically dust-free, the tar will find a ready market in the East. The separation of light and heavy oils from the tar is not recommended because they are comparatively plentiful and inexpensive in the United States. Since the farmers in the lignite states can make excellent use of ammonium sulphates for fertilizing purposes it is advisable to separate this product from the tar water.

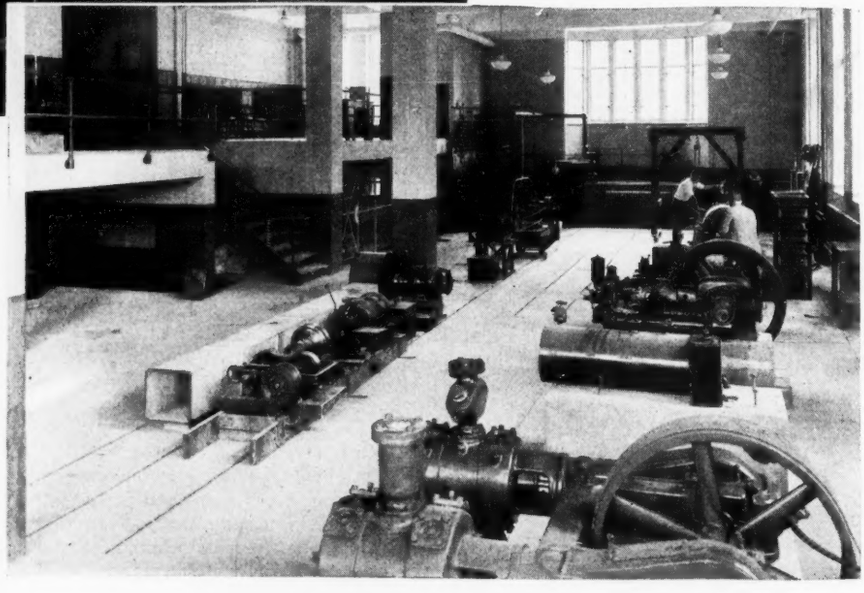
# *Events and Men in Power's Field*

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

## Princeton University Dedicates New Engineering Building

### Laboratories with most modern equipment given formal opening before distinguished group of educators

*Princeton's New Engineering Building*



*View of the Mechanical Engineering Laboratory*

MORE than 100 prominent engineers and faculty representatives from colleges and engineering schools throughout the East were present on Nov. 15, at the formal dedication of the new engineering laboratory recently completed at Princeton University, Princeton, N. J. Among the speakers for the occasion were Dean Dexter S. Kimball of the Cornell Engineering College; Dean Augustus Trowbridge of the Princeton Graduate College, and Carlton S. Proctor, of New York, president of the Engineering Association. Others present at the ceremonies included Alfred D. Flinn, director of the Engineering Foundation, and Dr. Charles L. Reese and W. C. Spruance, vice-presidents of the DuPont company, and F. R. Low, Editor of *Power*.

The engineering building, which was erected at a cost of $500,000, was opened for classes at the beginning of the present college year, but the dedication was postponed until its completion recently. The new addition to the Princeton campus is Collegiate Gothic in style, in keeping with the new university chapel and McCosh Hall, across Washington Road. The building is three stories in height, with a floor area of 50,000 sq.ft. There are three large laboratories, in addition to fourteen classrooms that will accommodate engineering students in the college and graduate school.

The equipment for experimental purposes includes steam, gas and refrigerating laboratories in the north wing, with a laboratory for hydraulics and electricity in the opposite wing. A research laboratory for faculty members and graduate students is provided on the second floor. A large oil-burning boiler has been installed in conjunction with the steam laboratory to provide steam for the engines and for testing purposes by the students.

Another feature of the modern equipment is a cooling tower 48 ft. high, which will be used for experimentation and as part of the refrigerating plant. The object of the laboratory work at Princeton, according to Dean Greene, of the Engineering School, is to supply the students with machines of sufficient size to get commercial results, yet not so large as to make the operating charges excessive. The dedicatory program was held in the hall of the new building, where John Grier Hibben, president of Princeton, received the keys from Charles Z. Klauder, architect. Later in the day a luncheon was held at the Princeton Inn, and the speeches of the occasion were delivered.

## Arc-Welded Power House

The new power house for the Chalfonte-Haddon Hall in Atlantic City, N. J., is under construction by the new method of electric arc welding.

## Graybar Company Sold to Employees

THE announcement that arrangements have been completed for the purchase of the Graybar Electric Company by employees of the company is one of the most important in the business world in years, according to a statement sent by the company to its employees recently. The transaction was announced by Edgar S. Bloom, president of the Western Electric Company, Inc., which owns Graybar Electric.

The ownership of the company will be in the hands of the Graybar Management Corporation, it was pointed out. This company was recently organized to enable officers and other employees of the Graybar Electric Company to buy the business. All the capital stock of the management company will be owned by officers and other employees of Graybar Electric and cannot be sold except to the company at book value.

"There will be three methods by which employees can purchase stock, namely, outright cash purchase, annual installments over five years, or payments of $2 a share per month, deducted from salary.

"The management of the Graybar Electric Company will continue as at present." A capitalization of $9,000,000 is announced.

## Heat Transmission Committee Reports Quarter's Progress

IN ITS quarterly report for the period ending Oct. 31, the Committee on Heat Transmission, of the National Research Council, surveys the annual activities that have occupied it this year. Excerpts from the report are as follows:

"We now have seven active committees engaged in the preparation of reports and technical information. These are: Committee 'A' (Promotion of Heat Transfer); Committee 'B' (General Insulation); Committee 'C' (Nomenclature and Definitions); and four Test Code Committees on High Temperature Insulation, Insulation in the Steam and Moderate Temperature Range, Building and Low Temperature Insulation and Electrical Insulation. In this group there are associated with our activities 68 individuals.

"The report of the Test Code Committee on Building and Low Temperature Insulation has been revised four times, and will be finally passed at the time of the annual meeting of the A.S.M.E., Dec. 3-7. The report of the Test Code Committee on Electrical Insulation has been revised three times, and will be finally passed upon by the committee during the annual meeting of the A.I.E.E., Feb. 1. The report of the Test Code Committee covering the Steam and Moderate Temperature Fields, has been prepared and is in the hands of the committee for further revision.

"The text (Promotion of Heat Transmission) in process of preparation by Professor McAdams, will be revised chapter by chapter as completed by the various members of his committee. In addition to this work, the executive committee has authorized the establishment of two or more fellowships whose object will be to pursue certain definite lines of investigation in this field, primarily with a view of solving certain factors and relationships which are in need of more accurate determination or further corroboration. The work will be supervised by this sub-committee.

"The executive committee has also decided to form another sub-committee 'D,' whose object will be to undertake numerous investigations in the field of heat transmission by radiation and, in this connection, to study the laws governing heat transmission from surfaces other than by convection or conduction. This committee is in process of formation. In addition to the foregoing, the office of the general committee has been engaged in compiling a bibliography of heat transfer, answering numerous questions both of a technical and economic character on the subject, and keeping abreast of developments in the general field."

## *In the News*

**The Second Plenary World Power Conference, announced in this issue, will demonstrate two great trends of the times; the sincere attempt to pool knowledge internationally, and the increasing subordination of technique to economic values. More and more as the world goes on will it be realized that it is not what *can* be done but what *should* be done that is important.**

## Pulverized Coal Burners Demonstrated

A group of about 60 engineers, Shipping Board and Navy officials on Nov. 13 were guests of the Todd Dry Dock Engineering and Repair Company at the final tests of a new type of coal pulverizing and burning units recently installed by the company at the League Island Navy Yard, in Philadelphia. The principal feature of the pulverizer design lies in the fact that both pulverizer and burner are combined in a single unit, which is attached to the front of the boiler and occupies an unusually small space. A 3,600-r.p.m. induction motor is mounted integrally with the unit and drives both the pulverizer and fan.

The demonstration units are installed on a three-furnace Scotch marine boiler, one unit being used on each furnace. This test was one of a series being made by the Navy Department for the purpose of determining the most suitable equipment for use on shipboard.

## J. A. Manley to Direct Fairbanks-Morse Sales

JOHN A. MANLEY, for the past three years manager of sales development for Fairbanks, Morse & Company, of Chicago, has been elected vice-president in charge of sales according to a recent announcement of the Board of Directors of that company. Mr. Manley, whose career has been one of rapid advancement in the business world, was formerly manager of accounts of the nationally known advertising agency of Henri, Hurst & McDonald, also of Chicago. In his connection with advertising work Mr. Manley made a detailed study of the problems of industrial business development, and it was the result of this work that brought him into the Fairbanks-Morse organization.

In 1911 he was graduated from Northwestern University and entered the sales department of the Republic Tire & Rubber Company. After four years with this organization he joined the advertising staff of one of the Chicago newspapers. Later, he was connected with Hart, Schaffner & Marx, studying the problems of the retail merchant, and after two years in this connection, went with Henri, Hurst & McDonald.

## Shawinigan No. 7 In Service

One of the largest power units in the British Empire—Shawinigan Water & Power Company's new No. 7 unit at Shawinigan Falls, Quebec—was brought into production on Nov. 5. This unit has a capacity of 45,000 hp. and its addition to the Shawinigan Falls station brings the total production of that plant up to 320,000 hp. Power produced by the Shawinigan system is rapidly approaching the 700,000 hp. mark.

No. 7 unit was completed within twelve months, the work having been carried out by the Shawinigan Construction Company, Ltd., which is now engaged upon the installation of No. 8 unit. This will be a duplicate of No. 7 and is expected to be producing by March 1, 1929.

## Diesel-Electric Ferryboat

A new Diesel-electric ferryboat is under construction for service between Norfolk and Portsmouth, Virginia. The hull is being built by Spear Engineers, Inc., of Norfolk; the Diesel engines are being constructed by the Bessemer Gas Engine Company, of Grove City, Pa., and the electric equipment will be furnished by the General Electric Company. It is expected to be ready for operation in the summer of 1929.

The new boat will have an over-all length of 173 ft.; and an over-all beam of 57 ft. The power plant will consist of two Diesel engines each rated 400 b hp. at 250 r.p.m., direct-connected to two 270-kw. generators. The main propulsion motor will be designed for a continuous rating of 650 hp. at 185 r.p.m.

# New Coventry Power Station Opens With 40,000 Kw.

## British Station Will Provide Base Load—Equipment of Latest Design

THE opening ceremony of the new power station at Coventry, England, took place recently in the presence of a large crowd of persons identified with the scheme. The station, which has been scheduled as a base-load plant in the national electricity scheme, is conveniently situated with respect to coal, water and supplies, the site being bordered by the Oxford Canal on one side, on the west by the London, Midland & Scottish Railway, and a main highway on a third. The system of sidings connected with the railroad gives direct access to the coal storage, engine room, basement and transformer bays.

The first section, containing two high-efficiency 20,000-kw. turbine-generators, is now in commission. The plant will handle coal at the rate of 50 tons an hour from the canal to the bunkers and 25 tons to storage simultaneously, or 50 tons of rail-borne coal to either. Because of the completeness of the station equipment there is no handling of coal by hand from the time it is received on the corporation property until finally deposited as ash.

Steam is supplied by eight Stirling tri-drum rapid-steaming boilers arranged in two rows, one unit in each row being a spare, with a central firing aisle. Each unit is designed for a normal hourly evaporation of 60,000 lb. of steam, with provision for 25 per cent overload. Feed water enters the economizer at a temperature of about 200 deg. F., and leaves it at about 300 deg. Steam is generated at 325 lb. per sq.in. gage, and is superheated to a total temperature of 700 deg. F. Each boiler is fitted with a pair of Bennis chain-grates, each grate having an effective width of 9 ft. and a length of 17 ft., giving a combined grate area of 306 sq.ft. per boiler. The grates embody a number of new features, including improved air-sealing arrangements. To secure efficient combustion and to regulate the amount of fuel required to be burnt for various boiler duties, the rear portions of the grates are provided with four pairs of regulating dampers, which form four cells. A complete boiler unit includes also a superimposed tri-tube economizer, ten soot blowers, induced-draft fan, and grit arrester. The ashes are discharged over the end of the chain-grate stokers automatically, and are passed directly into a Bennis submerged conveyor, which automatically quenches them and discharges them into reinforced-concrete storage bunkers.

Each of the main turbine-generator sets consists of a high-efficiency, two-cylinder, double-flow turbine driving a main generator, service generator and main and auxiliary exciters. The speed is 3,000 r.p.m., and the turbines have a total of 21 stages. Nozzle control of steam admission to the casing of the high-pressure cylinder, which is of the impulse type, is employed because of the high efficiency obtainable from this method of control, and an exceedingly sensitive system of governing is fitted. The low-pressure casing is of the double-flow type. The turbines give their maximum continuous rating without bypassing high-pressure steam to the lower stages of the high-pressure units when supplied with steam at 300 lb. pressure and 700 deg. F. temperature, and when exhausting into a vacuum of 28 in. with the barometer at 30 in.

Should the initial steam conditions become bad or the vacuum fall, the turbines will still give their maximum continuous rating, but with the high-pressure steam bypassed to lower stages. Twin-surface condensing plant is installed, each equipment being designed to maintain a vacuum of 28 in. when dealing with 145,000 lb. of steam per hour and supplied with circulating water at a temperature not exceeding 80 deg. F. Feed-water heating is arranged on the closed system. There are four cooling towers, each with a normal capacity of 528,000 gal. per hour. Constructed of reinforced concrete and of hyperbolic shape, they have a diameter at ground level of about 100 ft. and rise nearly 130 ft. above the ground.

The main generators are wound for 6,600 volts, three-phase, 50 cycles, and each is rated to give 25,300 kva. at 74 per cent power factor.

## High Efficiency Expected in "Celanese" Plant

The degree of efficiency that may be attained in industrial plants using process steam is to be raised a notch higher in the Cumberland, Md., plant of the Celanese Corporation of America, it is announced. Unusually careful attention paid to the heat balance of the new equipment is given as the reason for this added efficiency. The ultimate demand for process steam at the Cumberland plant will be about 1,000,000 lb. per hour, and will be used in the manufatcure of yarns, fabrics, etc. A moderately high boiler pressure of 450 lb. will be used, the initial path of the steam being through turbine-generating units which discharge directly into the process steam lines.

The high-pressure steam generating equipment will be furnished by the Babcock & Wilcox Company, of New York. Integral economizers, Taylor multiple-retort stokers, water-cooled furnace walls and superheaters are some of the features planned for the new installation. The main generating units, to be added at some future date, will consist of 6,000-kva. high-pressure turbines operating at 400 lb. pressure at the throttle and with an initial steam temperature of 695 deg. F. The turbines will exhaust at 60 lb. back pressure into the process steam mains. The heat balance will be maintained without the use of condensers by means of an evaporator system which will utilize high-pressure steam for evaporating makeup water and slightly superheating the steam thus produced before introducing it into the process lines along with the exhaust steam from the turbines. This operating cycle will make an extremely efficient plant, it is believed, capable of producing both steam and electric power at unusually low cost.

The designing engineer in charge of the new plant is L. E. Lovett, assistant chief engineer of the Celanese Corporation.

## New York Merchants Study Smoke Problem

In an effort to aid the municipal authorities of New York City in their attempted solution of the smoke nuisance problem, the Merchants' Association through its Bureau of Research has completed a survey of the smoke-abatement methods of Chicago, Cleveland, St. Louis, Pittsburgh and Cincinnati. The results of this study were placed before the board of directors of the association at a recent meeting.

The findings of the Bureau of Research were summarized in part as follows:

"All the cities studied, except New York, give control over installation of fuel-burning apparatus. This preventive control would be given under the proposed plan.

"All the cities studied, except New York, are following a policy of education and persuasion to get results, rather than relying upon court prosecutions.

"In St. Louis, Pittsburgh and Cincinnati the smoke-abatement work is handled by officials with no other duties. In Cleveland the Division of Smoke Abatement also controls refrigerating machinery with no apparent harm to smoke-abatement work other than the loss of time. In Chicago, however, the transfer of smoke-abatement work from the Health Department to the Bureau of Boiler Inspection has, together with political conditions, seriously reduced the effectiveness of the work.

"All the other cities studied make general use of high-volatile coals both for industrial and residential purposes. The result is a far more serious problem of reducing the volume of smoke from homes than in New York, where a far larger proportion of anthracite is burned. The reluctance to take drastic steps against the smoke nuisance from homes resulted in their exemption from the control in Pittsburgh, and practical exemption in Chicago. In the other three cities reduction of smoke from homes is the most serious part of the problem. The proposed plan in New

York would attack this phase by requiring all domestic users of fuel to pledge themselves to the use of 'smokeless' fuels or be subjected to the same control of installations as other users.

"The proposed plan for New York appears to be in accord with the best practice of other cities in respect to placing the task of smoke abatement in the hands of a force engaged solely in that work and empowered to control the installation of fuel-burning apparatus, but to be excessive in respect to the number of the proposed staff. It is felt that a staff of 50 persons should be adequate to do the work of smoke abatement."

## Purdue Chosen for Teachers Meeting in 1929

The Society for the Promotion of Engineering Education is making preliminary plans for its annual summer school for engineering teachers. Purdue University, at Lafayette, Ind., has been chosen as the place of meeting. It has been the custom of the society for some years past to assemble a group of engineering teachers of all ranks during the summer months for special instruction in some branch of engineering teaching. In each of the summer schools so far held a separate phase of technical instruction has been taken up.

For the coming year mechanical engineering has been selected as the subject of the session which will be held at Purdue University for three weeks beginning late in June. A limit of attendance of 75 has been set. The program will be arranged in three principal divisions—heat and power engineering, machine design, and administration and management—the expectation being that approximately equal numbers of teachers will enroll in each of these three groups. There will also be general sessions of the school devoted to principles of teaching which apply to all subjects of instruction. Dean A. A. Potter, of Purdue University, will serve as the local director of the session which is in the general charge of Prof. H. P. Hammond, Associate Director of Investigation of the Society for the Promotion of Engineering Education. The teaching staff will be chosen from among the foremost teachers of mechanical engineering of the country, and there is a possibility that one expert will be brought to this country from Europe as a special lecturer.

## Italy Completes Building of Marmore Plants

A new electric power station with a capacity of 40,000 kw. has just been completed at Maen, in the Valtournanche, Aosta, Italy. This is the last of four hydro-electric stations constructed for the utilization of the basin of the River Marmore, at Perreres, Cavalou, Chantillon and Maen respectively. They have a total capacity of 110,000 kw., and their estimated power output is 230,000,000 kw.-hr. per annum.

# Second Plenary World Power Conference To Be Held in Berlin, June, 1930

### International Meeting will discuss power from every angle—Economic considerations to be uppermost

BERLIN, Germany is the meeting place for the Second Plenary World Power Conference, where, on June 16-25, 1930, noted engineers from every country in the word will meet to discuss the national and international aspects of power. The announcement of the program was made at a dinner at the Engineers Club in New York City on Nov. 14, at which several prominent German and American engineers met to discuss the plans for the Conference.

The 1930 Power Conference will be the second in history to be held in plenary session, the first having been convened in London in 1924. Several sectional conferences have met and are still to meet in the six years between the two plenary sessions, among them the London Fuel Conference, recently met, and the sectional meeting on the development of power resources, to be held in Tokio in the fall of 1929.

Dipl.-Ing. F. zur Nedden, assistant secretary of the German National Committee for the 1930 Conference, discussed the meeting in considerable detail at the dinner, presenting the general outline of the program, already carefully planned and divided into sections. The principal stress, he pointed out, will be laid on the economic side of developments in power generation, transmission and application. The test of the dollar sign, or its equivalent, will be applied to every question discussed. Design details will hold a place of subordinate interest.

The tentative technical program as released by Herr zur Nedden, covers four general classes of papers and recommends that papers prepared should not be detailed reports but, instead, short accounts discussing the larger bearing of each subject. The four classes are: A. Sources of Power; B. Power Production—Transmission—Storage; C. Utilization of Power; D. General, a section in which distribution, legislation, education and co-operation will be discussed.

The speaker pointed out that the last two divisions were regarded by the German national committee as the most important. The subjects under sources and production of power had already been thoroughly covered in previous conferences, he said. "It seems advisable," he continued, "not again to stress this side of the power problem too much, but rather to transfer the center of gravity of this next Plenary Conference to questions relating to transmission, distribution and utilization of power. All efforts of the engineer to produce, transmit or store up power as cheaply as possible will be futile if the consumers of power are not taught to utilize it to the best advantage. Papers dealing with new methods for utilizing and marketing power will be particularly welcome.

"It will also be desirable," said Herr zur Nedden, "to promote the use of power by bringing forward points of special interest to politicians, leading business men, financiers and communities as a whole. National committees are particularly invited to turn to associations not only of engineers, but of business men, economists and legal experts, and to solicit papers from them for the 1930 Conference, in order to bring forward for discussion the points that would require to be cleared up in co-operation between technical and non-technical men, producers and consumers of energy."

Of special interest to readers of *Power* will be the papers in the Class B section of the Conference. These will include discussions of control of boiler plants, high-pressure steam generation, mercury vapor turbines and binary vapor turbines, heat accumulators, increased speed of internal-combustion engines, and the use of pulverized coal in internal-combustion engines.

The dinner at which these remarks were made was held for the purpose of organizing in this country the plans for the 1930 Conference. Beside Herr zur Nedden the guests included: O. C. Merrill, general chairman of the American Committee; Dr. Calvin W. Rice, secretary of the A.S.M.E. and member of the executive committee of the World Power Conference; Dr. E. W. Smith, technical secretary of the recent London fuel conference; David B. Rushmore and H. J. Pierce, members of the executive committee; Ernest Hartford, assistant secretary of the A.S.M.E.; and P. W. Swain, managing editor of *Power*. Messrs. zur Nedden and Smith had arrived from Europe on the S.S. "Majestic" a few hours before the dinner was held.

## A $9,000,000 Project

The Public Service Commission of West Virginia approves the construction of two power dams at Hawk's Nest on New River, by the New-Kanawha Power Company and will authorize the construction as soon as a detailed agreement has been worked out between the company and state officials. The projects are part of a plan to utilize the water power of the Kanawha River and its tributaries in the production of chemicals for the Union Carbide & Carbon Company, New York, of which the New-Kanawha Power Company is a subsidiary. It is estimated that the initial expenditure will be about $7,000,000 and the ultimate expenditure $9,000,000.

The development of this project is

said to be a step in the direction of establishing a new manufacturing center in the vicinity of Glen Ferris, W. Va., at the mouth of the Gauley River. Land rights for the construction of one group of plants at Boncar, which will rival in size the United States Ordnance plant at South Charleston, are said to have been acquired by the company already. According to Louis N. Davis, executive vice-president of the Union Carbide & Carbon Company, and an official of several subsidiaries, plans for the development of the power project were formulated about 18 months ago. It is planned to build big manufacturing plants to utilize the power developed.

## Flood Control Act Showing Results

Progress has been such on the power, flood control and irrigation surveys of the nation's streams authorized under the Flood Control Act of 1928, that the office of the Chief of Army Engineers expects that half of the reports will be completed by the first of the year. Attention has been called to the fact that there is a scarcity in the number of competent hydraulic engineers available because of the great number required in the execution of this work. The progress of the work is being watched closely by the engineers staff in Washington and charts have been set up recording the status of the project on the streams and rivers of each of the 42 engineering districts.

The report on flood conditions at Pittsburgh, for which Congress made separate provision, is expected to be in the hands of the Chief of Engineers before the end of November. It it understood that, among other things, this report will recommend the diversion of water from the upper Allegheny into Lake Erie during high water stages at Pittsburgh. Such diversion, it is claimed, will be of advantage in raising the levels of Lakes Erie and Ontario and also will make possible more power development at Niagara. It is estimated that 100,000 kw. of primary power will be made available at Dunkirk, where the water will be discharged into Lake Erie.

## Idaho Project Approved

The Deadwood basin power reservoir and dam for the Black Canyon project, tributary to Emmett, New Plymouth, Caldwell and Boise, Idaho, is to be constructed. It involves the expenditure of $900,000.

The information reached Boise direct from Senator Borah that President Coolidge has approved the certificate of feasibility authorized by the Secretary of the Interior under the terms of the Factfinders Bill passed by Congress.

The Deadwood reservoir is for impounding water for power purposes. It will be located in the Deadwood basin and will become part of the Black Canyon project.

# OBITUARY

RICHARD L. HUMPHREY, distinguished for his work in mechanical engineering and chairman of the Pennsylvania State Board for the registry of professional engineers and surveyors, died on Nov. 3.

THEODORE C. ROBERTS, consulting engineer, died suddenly Sept. 28, at his home, 468 Riverside Drive, New York City. He was identified for many years with the mining and railroad interests in the far West and was at one time chief engineer for the H. M. Byllesby Company. During the World War he was engaged in the manufacture of chemicals and dyes, and subsequent to that service, he was chosen assistant to the president of the Columbia Graphophone Company. Since 1923 he had devoted most of his time to consulting engineering and the writing of scientific articles. He was a member of the American Society of Mechanical Engineers, as well as of the National societies of civil, mining and electrical engineering.

# PERSONALS

J. E. DAVIDSON was elected president of the Nebraska Power Company at a recent meeting of the board of directors of the company.

DR. JOHN H. GREGORY, of the Johns Hopkins University School of Engineering, is employed by the Baltimore Public Improvement Commission as general consultant in matters pertaining to new $10,000,000 water improvement projects.

LEVEN D. GRAY, formerly connected with the Dayton Power & Light Company of Dayton, Ohio, is now affiliated with the Union Electric Light & Power Company, of St. Louis, Mo., in the capacity of steam distribution engineer.

J. A. MCGILLVRAY, until recently resident engineer for the Manitoba Power Company, Ltd., at Great Falls, has been transferred to Point du Bois, on the Winnipeg River, where he will be construction engineer.

J. H. GANDOLFO, formerly chief designing engineer of the Northern New York Utilities, Inc., and the Power Corporation of New York from the time of the organization of the engineering of these companies in December, 1922, has begen appointed assistant director of the division of architecture and construction of the state of New Jersey.

CLARENCE L. LAW has recently been made acting general commercial manager of the New York Edison Company, New York City.

ROLAND A. PACKARD, who, for the last eight years, has been mechanical engineer for the Ludlow Manufacturing Associates, two years of which were spent in a large plant just south of Calcutta, India, ironing out construction difficulties, has now returned to the United States as plant engineer of the Smith Paper Company, Lee, Massachusetts.

MATTHEW S. SLOAN was elected president of the Yonkers Electric Light & Power Company at a recent meeting of the Board of Directors. Mr. Sloan is now chief executive of five companies supplying electric light and power in the Greater New York area, the others being the New York Edison Company, the Brooklyn Edison Company, the United Electric Light & Power Company and the New York and Queens Electric Light & Power Company. They are being operated as a system with unified management.

GUY L. WARDEN, Pacific Coast representative of The Engineer Company, announces that he has moved to 114 West 17th St., Los Angeles, Calif., where he is much better prepared to take care of his growing business interests on the Pacific Coast.

## Coming Conventions

**American Institute of Electrical Engineers,** annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

**American Institute of Refrigeration,** at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

**American Society of Heating and Ventilating Engineers,** 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

**American Society of Mechanical Engineers,** annual meeting, in New York City, Dec. 3-7. Calvin Rice, secretary, 33 West 39th St., New York City.

**American Society of Refrigerating Engineers,** at New York City, Dec. 2-6, 1928. David S. Fiske, secretary, 37 West 39th St., New York City.

**Association of Iron and Steel Electrical Engineers,** 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

**Engineering Institute of Canada,** annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

**Master Boiler Makers Association,** at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

**Midwest Power Conference and Exhibition,** at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

**National Association Practical Refrigerating Engineers,** annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

**National Exposition of Power and Mechanical Engineering** will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

**Second Bituminous Coal Conference** will be held at Pittsburgh, Nov. 19-24.

**World Engineering Conference,** Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

# Society Notes

A.S.M.E.—Chicago Section. Joint meeting with the mechanical section of the Western Society of Engineers, in the Engineering Auditorium, Dec. 3. Subject: "What Things Are Made Of," by Doctor Compton, University of Chicago.

A.S.M.E.—Raleigh, N. C., Section. Meeting Nov. 22. Subject: "Conservation and Development of Natural Resources," by Major Wade Phillips.

A.S.M.E. — Philadelphia Section. Meeting, Nov. 27. Subject: "Conowingo Hydro-Electric Development," by Alexander Wilson, 3rd, Assistant Chief Engineer, The Philadelphia Electric Company.

A.S.H. & V.E. — Massachusetts Chapter. There will be a meeting in Boston on Dec. 3, at which A. C. Willard, president of the society, will speak.

A.S.H. & V.E.—Council Meeting in New York City, Dec. 6, at 29 West 39th St. At this meeting the program of the annual meeting will be discussed.

American Water Works Association, Kentucky-Tennessee Section—Annual meeting will be held Jan. 24-26, at Chattanooga, Tenn. F. C. Dugan, secretary, Kentucky State Board of Health, 532 W. Main Street, Louisville, Ky.

# Business Notes

The National Flue Cleaner Company, Incorporated, of Groveville, N. J., announces the appointments of three new Ohio sales representatives: Craun-Liebing Company, of Cleveland; Dennis Engineering Company, of Columbus; and the Bishop Engineering Company, of Cincinnati. Another recent appointment was the Rathburn Company of El Paso, Tex.

The Ralph M. Sitterley Company, 1149 Broadway, New York City, announces that its Japanese representative has been in the city Nov. 15 and after, and will be interested in receiving offers for electrical lines for use in the industries.

The Pennsylvania Pump & Compressor Company, Easton, Pa., announces the appointment of representatives as follows: in Pittsburgh, Pa., J. F. Rodgers, 726 Oliver Bldg., and in Boston, Mass., Gustavo Preston, 113 Broad St.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces the appointment of H. H. Ashinger as assistant to the general manager and manager of engineering for the South Bend works of the company. Mr. Ashinger was for thirteen years in the employ of the George Cutter Company, which was taken over by the Westinghouse company.

The Consolidation Coal Company, New York City, announces that at a regular meeting of the board of directors Nov. 7, Thomas I. Parkinson was elected a director to fill vacancy created by an amendment to the by-laws, adopted on Oct. 31, increasing the directorate.

The Power Plant Equipment Company, Kansas City, Mo., announces that it has opened an office in New York City at 342 Madison Ave. A further announcement is to the effect that the company's name has been changed to the Marley Company.

The Atlas-Imperial Diesel Engine Company of Oakland, Calif., announces that the new headquarters of its Eastern division has been opened at 115 Broad St., New York City.

The Fuel Efficiency Engineering Corporation, formerly of the American-Trades National Bank Building, Birmingham, Ala., has moved to 810 Protective Life Building, in the same city.

# Fuel Prices

## COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

| Bituminous (Net Tons) | Market Quoting | Price per Ton |
|---|---|---|
| Navy Standard | New York | $2.35@$2.60 |
| Kanawha | Columbus | 1.35@ 1.75 |
| Smokeless | Cincinnati | 2.25 |
| Smokeless | Chicago | 2.25 |
| S. E. Kentucky | Chicago | 1.35@ 1.60 |
| Steam | Pittsburgh | 1.65@ 1.80 |
| Gas Slack | Pittsburgh | 1.00@ 1.20 |
| Big Seam | Birmingham | 1.25@ 1.50 |
| **Anthracite** (Gross Tons) | | |
| Buckwheat | New York | $2.75@$3.00 |
| Barley | New York | 1.25@ 1.75 |

## FUEL OIL

**New York**—Nov. 15, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

**St. Louis**—Nov. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3709 per bbl. or 42 gal.; 26@28 deg., $1.4209 per bbl.; 28@30 deg., $1.4709 per bbl.; 30@32 deg., $1.5209 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., 5.105c. per gal.

**Pittsburgh**—Nov. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5½c. per gal.

**Philadelphia**—Nov. 12, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

**Cincinnati**—Nov. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

**Chicago**—Nov. 12, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

**Boston**—Nov. 12, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.55c. per gal.; 28@32 deg., 5.6c. per gal.

**Dallas**—Nov. 10, f.o.b. local refinery, 26@30 deg., $1.20 per bbl. or 42 gallons.

# Trade Catalogs

Circuit Breakers—Bulletin 220, just issued by the I.T.E. Circuit Breaker Company, Philadelphia, Pa., is an eight-page publication dealing with circuit breakers grouped on steel panels for distribution service. Numerous views of the breakers are included, showing the methods of assembly.

Compressor Standards — The third edition of "Trade Standards" pamphlet has been published by the Compressed Air Society. It has been considerably enlarged and improved, comprising 47 pages with numerous illustrations and tables that will be of assistance in the treatment of various compressor problems. New material that has been added includes a description of the A.S.M.E. standard air receivers with list of standard sizes of these receivers; pneumatic tool standards; a section on portable compressors; and additional information relating to the installation and care of compressors. The price of the pamphlet is fifty cents and copies may be had upon application to the secretary, C. H. Rohrbach, 90 West Street, New York City.

Centrifugal Pumps—The Dayton-Dowd Company of Quincy, Ill., tells, in its new bulletin No. 267, the story of its double suction single stage centrifugal pumps. The bulletin fills 38 pages, in which the product is thoroughly described and pictured. A number of cutaway photographs help to demonstrate the inner construction of the pumps and a large section at the back of the publication is devoted to installation views.

Power Plant Equipment—Catalog No. 90, just issued by the Hoppes Manufacturing Company, devotes its 88 pages to a complete description of feedwater heaters, purifiers, steam separators, oil eliminators, exhaust heads, and V-notch water meters. The publication is illustrated with many cutaway views of the equipment, which materially assist in understanding the principles of operation.

Gas Burner—A general descriptive four-page bulletin has just been issued by the Webster Engineering Company, Tulsa, Okla., covering "radiant" gas burners for industrial use. The product is intended for the burning of natural gas under boilers of all sizes.

Hydraulic Standards — The fifth edition of the Standards of the Hydraulic Society has just been published. The principal changes from the preceding edition are a revision of the extracts taken from the A.S.M.E. Test Code for Centrifugal and Rotary Pumps and changes in materials recommended for the construction of special service pumps, in line with the latest accepted practice. The pamphlet contains 80 pages, is profusely illustrated and is priced at fifty cents. Copies may be had upon application to the secretary, C. H. Rohrbach, 90 West Street, New York City.

# *New Plant Construction*

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Ala., Mobile** — Southeastern Production Co., subsidiary of Southeastern Power & Light Co., 120 Broadway, N. Y., has work under way on the construction of first unit of combination steam and electric plant here, to supply steam and power to International Paper Co.'s plant, initial capacity 10,000 hp. Initial cost $1,300,000, ultimate total cost $8,000,000. Work will be done by Dixie Construction Co., a subsidiary of Southeastern Light & Power Co.

**Calif., Los Angeles**—City Towel Supply Co., 413 East 6th St., awarded contract for the construction of a laundry, including boiler room on South San Pedro St., to Easton & Nesser, 323 South Western Ave. Estimated cost $135,000.

**Calif., Pittsburg**—Pacific Gas & Electric Co., 445 Sutter St., San Francisco, had plans prepared for the construction of an electric sub-station, also six mile double circuit high tension transmission line here. Estimated cost $250,000. Private plans.

**Ill., Downers Grove**—American Federation of Labor, 623 Wabash Ave., Chicago, will soon receive bids for the construction of a broadcasting station, including a 50,000 kw. generating station, here. Estimated cost $350,000. M. F. Strauch, 800 West North Ave., Chicago, is architect.

**Mass., Malden** (Boston P. O.)—Boston Ice Co., 11 Deerfield St., Boston, awarded contract for the construction of a 125 x 150 ft. ice plant on Phillips Court to Vappi & Ferguson, 552 Massachusetts Ave., Cambridge, Mass. Estimated cost $75,000.

**Mass., Mattapan** (Boston P. O.)—Milton Ice Co., 45 Babson St., awarded contract for addition to ice plant, to W. T. Reed Co., 201 Devonshire St., Boston.

**Miss., Durant** — Lewis Grocery Co., M. Lewis, Pres., is having preliminary plans prepared for the construction of a cold storage plant. Estimated cost $50,000.

**Mo., Springfield**—Empire District Electric Co., subsidiary of H. L. Doherty Interests, 66 Wall St., New York, N. Y., has been granted authority by Missouri Public Service Commission to construsct a hydro-electric development on the White River at Tablerock near Branson. Plans include a dam 1,924 ft. long and 197 ft. high, 410,000,000 kw. annual capacity. Estimated cost approximately $16,700,000. Work will be done by owners forces.

**Neb., Edison**—City plans waterworks improvements including wells, pump house, mains, etc. Estimated cost $20,000. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

**Neb., Unadilla**—City, K. C. Stoner, Clk., is having plans prepared for waterworks improvements including wells, pump house, tank on tower, etc. Estimated cost $25,000. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

**N. J., Jersey City**—Public Service Electric & Gas Co., 80 Park Pl., Newark, is having revised plans prepared for an electric sub-station at 94½ to 109 Morgan St. Estimated cost $55,000. Public Service Production Co., 80 Park Pl., Newark, is engineer.

**N. J., Long Branch**—Seaboard Ice Co., Second St. and Union Ave., will build a 40 ton ice plant. Estimated cost $40,000. M. Smith, 2 Lafayette St., New York, N. Y., is engineer. Work will be done by separate contracts.

**N. J., South Amboy**—Jersey Central Power & Light Co., 20 South St., Morristown, subsidiary of National Light & Power Co., 57 William St., New York, N. Y., is having sketches made for the construction of a steam operated electric generating plant, 50,000 kw. capacity at waterfront here. Estimated cost $5,000,000. Electric Planning & Engineering Corp., 57 William St., New York, N. Y., is engineer.

**O., Barberton**—Henry Coal & Ice Co., c/o A. R. Henry, Pres., is receiving bids for an ice plant. Estimated cost $50,000. George B. Bright Co., 2615 East 12th St., Detroit, Mich.

**Tenn.** — Tennessee Electric Power Co., subsidiary of Nashville Railway & Light Co., Watkins Bldg., awarded contract for the construction of four new sub-stations at Nashville, Centerville, McEwen and Hohenwald, also new transmission lines to run east and south from Nashville through Centerville to Hohenwald and from Centerville north to McEwen to Stevens & Whood, 20 Pine St., New York, N. Y.

**Tex., Brownsville** — Dixie Development Co., c/o A. R. Jones, 900 Land Bank Bldg., Kansas City, Mo., is receiving bids for the construction of a pumping plant and distribution system, etc., on the Rio Grande River, here, in connection with irrigation project. Estimated cost $200,000. Private plans.

**Tex., Harlingen**—Central Power & Light Co., Frost Bldg., San Antonio, c/o F. O. Ludden, Mgr., San Benito, plans the construction of a cold storage plant here. Estimated cost $50,000. Private plans.

**Va., Snowden** — Rosecliff Development Corp., owned and controlled by M. E., I. J. and M. M. Marcuse, Mutual Bldg., Richmond, awarded contract for the construction of a hydro-electric plant on the James River near here, initial capacity 13,000 hp. to Reinehart & Dennis, Inc., Charlottsville. Estimated cost $1,500,000. Contracts awarded to Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. for electrical equipment and to James Leffel & Co., Springfield, O. for turbines, 5 units, 2,600 hp. each.

**B. C., Trail**—West Kootenay Power & Light Co., Rossland, has made application to Provincial Government for permit to construct a hydro-electric plant on the Pend Orielle River here to develop 80,000 hp. Estimated cost $4,000,000. L. A. Campbell, Rossland, is engineer.

**Ont., St. Catharines**—City plans the construction of a city hall, including steam heating system, etc., on James St. Estimated cost $1,000,000. B. F. Lamson, City Hall, is engineer.

**Ont., Toronto** — Canadian National Exhibition, Lumsden Bldg., is having competitive plans made for the construction of an exhibition building, including steam heating system. Estimated cost $1,000,000. Architect and engineer not selected.

## Equipment Wanted

**Boiler**—City Council, Columbus, O., authorized a bond issue of $40,000 for the installation of a 1,000 hp. boiler in municipal light plant.

**Boilers** — Institutions Dept., Boston, Mass., plans to purchase new high pressure boilers for Long Island Hospital. $25,000.

**Engine and Generator**—Gardner-Edwards Co., Inc., Ludlow, Vt., is in the market for a 150 to 200 hp. Corliss type engine, 150 hp. generator, 200 v., a.c. belt driven, 600 r.p.m.

**Generator** — Bureau of Yard & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 28 for a turbo generator and auxiliary equipment at Naval Academy, Annapolis, Md.

**Generator** — Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Dec. 12 for an electric generator for Buffalo State Hospital, Buffalo, N. Y.

**Generator and Condenser**—Dept. of Service, W. H. Duffy, Purch. Agt., City Hall, Columbus, O., plans to purchase (after Jan. 1), a 750 kw. steam turbine generator and condenser for municipal light plant.

**Motor**—Pitman & Brown Co., 11 Washington St., Salem, Mass., is in the market for a 35 or 40 hp. a.c. motor with compensator.

**Motor Generator Set, Switchboard, etc.**—A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Nov. 27 for motor generator set and control switchboard, etc.

**Pump**—City of Long Island, Kan., plans to purchase pump, etc., for proposed waterworks improvements. Estimated cost $25,000.

**Pump**—City of Orillia, Ont., plans to purchase an electrically driven sewage pump for proposed sewage treatment work. Estimated cost $85,000.

**Pumps, Motors, Compressors, etc.**—City of Oshawa, Ont., c/o W. C. Smith, plans to purchase pumps, electric motors, compressors, etc., for proposed sewage disposal plant. Estimated cost $534,600.

## Industrial Projects

**Conn., Hartford**—GOLD LEAF FACTORY—M. Swift & Sons, 100 Love Lane, is having plans prepared for the construction of a 2 story, 55 x 200 ft. factory including boiler house, etc. Estimated cost $100,000. Mychreest & Reynolds, 238 Palm St., are architects.

**Ga., Augusta**—REFRACTORIES PLANT—Babcock & Wilcox Co., 85 Liberty St., New York, N. Y., will build first unit of refractories plant here. Ultimate cost $1,000,000. Work will be done by separate contracts and day labor.

**Ill., Chicago**—AUTOMOBILE SUPPLY FACTORY—Stewert Warner Speedometer Co., 1828 Diversey Parkway, awarded contract for masonry, etc. for a 10 story, 88 x 103 ft. factory for the manufacture of automobile supplies, speedometers, bumpers, etc. at 2825 North Lincoln St. Estimated cost $300,000.

**Md., Baltimore** — ICE CREAM MANUFACTURING PLANT—Maryland Creamery Co., 1726 East Pratt St., is having revised plans prepared for a 3 story addition to ice cream manufacturing plant at 127 Register St. Estimated cost $200,000. McCormick & Co., 121 South Nagley St., Pittsburgh, Pa., are architects.

**Md., Baltimore** — CABLE FACTORY — Western Electric Co., E. S. Bloom, Pres., 195 Broadway, New York, N. Y., subsidiary of American Telephone and Telegraph Co., plans the construction of first unit of plant for the manufacture of telephone cable and wire here. Estimated total cost approximately $15,000,000.

**Mass., Cambridge** (Boston P. O.)—RUBBER FACTORY—Cambridge Rubber Co., 748 Main St., plans the construction of a 5 story, 80 x 180 ft. rubber factory at 750 Main St. Estimated cost $100,000. Architect not selected.

**Mich., Detroit** — AUTOMOBILE FACTORY—Hudson Motor Car Co., 12601 Jefferson Ave., awarded contract for a 2 story, 80 x 345 ft. automobile factory on Jefferson Ave. to Otto Misch Co., 159 East Columbia St.

**Mich., Jackson**—GEAR FACTORY—Frost Gear & Forge Co. awarded contract for a 1 and 2 story, 100 x 160 ft. and 50 x 100 ft. factory on South Horton St. to North Moeller Co., 120 Cortland St. Estimated cost $75,000.

**Mich., Lansing**—WHEEL FACTORY—Motor Wheel Corp., Saginaw St., awarded contract for a 1 story, 220 x 220 ft. wheel factory on May Ave., to H. G. Christman Co., Porter Apartment Bldg. Estimated cost $75,000.

**Miss., West Point**—PRODUCE PLANT—Swift & Co., Packers and Exchange Aves., Chicago, Ill., awarded contract for the construction of a 76 x 127 ft. produce plant, including cold storage plant, etc., here, to Smallman Construction Co., 1109 South 5th Ave., Birmingham, Ala.

**Ont., Mount Denis**—BOX FACTORY and POWER HOUSE—Firstbrook Boxes Ltd., 283 King St. E., Toronto, awarded general contract for the construction of a 2 story, 160 x 320 ft. factory including 46 x 71 ft. power house, etc., to Jas. A. Wickett Ltd., 16 Saulter St., Toronto. Estimated cost $350,000.

**Ont., Princeton**—MILK CONDENSERY—City Dairy Co., Ltd., Spadina Crescent, Toronto, awarded general contract for the construction of 2 story milk condensery here, to James A. Vance, Woodstock. Estimated cost $125,000.

**Ont., Windsor** — AUTOMOBILE FACTORY and POWER HOUSE — Chrysler Corp. of Canada, J. D. Mansfield, Mgr., will receive bids about Nov. 14, for the construction of a 5 story, 280 x 1,000 ft. factory, including loading dock, storage building, power house, etc., on Tecumseh Rd. Estimated cost $1,500,000. Hutton & Souter, 6 James St. S., are architects.